THE ENGINEER.

The Shipping, Engineering and Machinery Exhibition at Olympia.

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The Shipping, Engineering and Machinery Exhibition, which opens at Olympia, London, on Monday, the 23rd, promises, so far as can be judged from a preliminary review of the stands, to be both interesting and successful. It would appear that the absence of an engineering section at Wembley this year has reacted in favour of Olympia. The list of exhibitors, not only numerically, but as regards quality or weight, is well up to the standard of similar exhibitions organised in past years. Indeed, remembering the great efforts made at Wembley in 1924 and bearing in mind the present very depressed state of the British engineering industry taken as a whole, we have to confess to some measure of pleasant surprise at the extent and nature of the support which has been forthcoming for the Olympia Exhibition. For reasons which are well known, the British machine tool trade is not represented, except on a very minor scale. That important section of the industry had its own Exhibition in September last year, and there can be no doubt that had it taken part in the Show which opens on Monday, the Main Hall and its extension at Olympia would have been uncomfortably crowded. There would, too, we believe, have been some loss of efficiency, for experience would seem to demonstrate that it is rational and desirable to separate the exhibition of machine tools from that of the products made with their assistance. Machine tools are of interest almost entirely to the manufacturing engineer. The exhibits now housed at Olympia appeal to many classes of the community, of which the manufacturing engineer is but one.

Nearly two hundred and fifty firms are represented at the Exhibition. To attempt to describe even a portion of the exhibits is a formidable task. A few only are dealt with in the pages of this Supplement, and others, including those in the special section devoted to motor boats, marine motors, &c., will be described in our ordinary columns before the Exhibition closes on December 5th. At an exhibition of this nature it would be wrong to expect a large number of novel devices or machines, for, as a means of increasing his trade, the manufacturer must regard it, and rightly so, as an occasion for displaying those of his goods which have reached an established manufacturing basis, rather than as an opportunity for calling public attention to possibly highly interesting, but still largely untried improvements and inventions. Moreover, to many visitors an exhibition such as that about to be opened affords the first chance of establishing direct contact with machines and appliances concerning which he may have heard or read, but which he has not previously seen or examined at close quarters. It would be unfair and unreasonable in these circumstances to insist on a high standard of novelty or unfamiliarity in the exhibits, and in our account of them some reflection of this fact must become apparent.

In what follows we have taken the stands entirely at random, and have dealt with them in the order most suited to our own convenience.

Vickers-Petters, Ltd.

On the stand of Vickers-Petters, Ltd., of Ipswich, there is to be seen a comprehensive exhibit, the leading feature of which is the new "C" type of low-compression two-stroke heavy oil engine recently placed upon the market by this firm.

Three different types of these engines are being shown, in addition to which there is a working model in which the sequence of operations in the engine cylinder is cleverly illustrated by lighting effects, whilst numerous component parts enable visitors to study the detailed construction of this new motor. The "C" type model embodies many improvements over the earlier hot-bulb type of engine, and it is claimed that increased economy of fuel and lubricating oil consumption is obtained with lower cylinder pressures and temperatures than those employed in other types of heavy oil engines. Illustration Fig. 1 shows the 100 brake horse-power reversible marine engine complete with its pumps, and designed for a running speed of 375 revolutions per minute, which is representative of many such engines, which the firm has supplied for yachts, barges and small marine craft. Another type of engine used afloat is the auxiliary lighting set, a view of which is reproduced in Fig. 2. It is a two-cylinder model, coupled direct to a 60-kilowatt generator. The same type of engine, arranged with pulleys for belt driving, has found a use in works and factories, and drawings of a two-cylinder 70 brake horse-power 350 R.P.M. model are given in Fig. 4.

A general idea of the main scantlings of the engine may be obtained from the last-named illustration. In particular, we would refer to the clean lines of the bed-plate, columns, and cylinders, and the neat way in which the automatic air inlet valves are arranged in the crank case. Crank case compression has been retained by Vickers-Petters, as experiments and research are held to have shown that this method gives excellent results. It has sometimes been urged that crank case compression gives rise to excessive use of lubricating oil, but a special design of sealing ring interposed between the crank case and bed-plate and the crank cheeks is claimed to prevent loss of air pressure or escape of lubricating oil.

The massive design of the bed-plate, the water-cooled bearings, and the reciprocating parts and the arrangements for the lubrication, are in accordance with the makers' standard practice.

The diagrammatic section through the engine at right angles to the line of the crank shaft, reproduced in Fig. 5, serves to indicate one phase of the two-stroke cycle of operations upon which the engine works. During the up stroke of the piston, pure air is drawn through the under part of the bed-plate, and enters the crank case through the automatic inlet valves. At the same time, the air in the cylinder space is compressed into the spherical combustion space, until at the end of the stroke a pressure of about 400 lb. per square inch is reached. Just before the top dead centre, a finely sprayed charge of fuel oil from the atomiser enters the heated air and ignites, causing a slight rise in pressure. The final pressure is maintained for a short period, after which the descending piston allows the gases to expand and to do work. As the piston nears the bottom dead centre and uncovers the scavenge air port, a charge of air from the crank case sweeps the cylinder and the combustion space, and drives all the products of combustion through the exhaust port, thus renewing the air charge.

The outstanding improvement in the new "C" type model is the introduction of a completely cooled, spherically shaped combustion space. A spherical shape gives, it is claimed, an ideal mixing chamber, and expansion difficulties are reduced to their simplest form. The general construction of the new type of cylinder head is illustrated in Figs. 4 and 5. In the smaller sizes of engines the cylinder head and its water jacket are formed by a single casting, but for the larger engines a separate cap is fitted over the combustion head—as shown in Fig. 5. The cap has the advantage that it can be easily removed for cleaning the cooling water space.

With an engine using airless injection, efficiency and fuel economy are largely bound up with a soundly designed and easily adjusted fuel pump, atomiser, and governor gear. A brief description of these integral parts of the Vickers-Petters engine is therefore

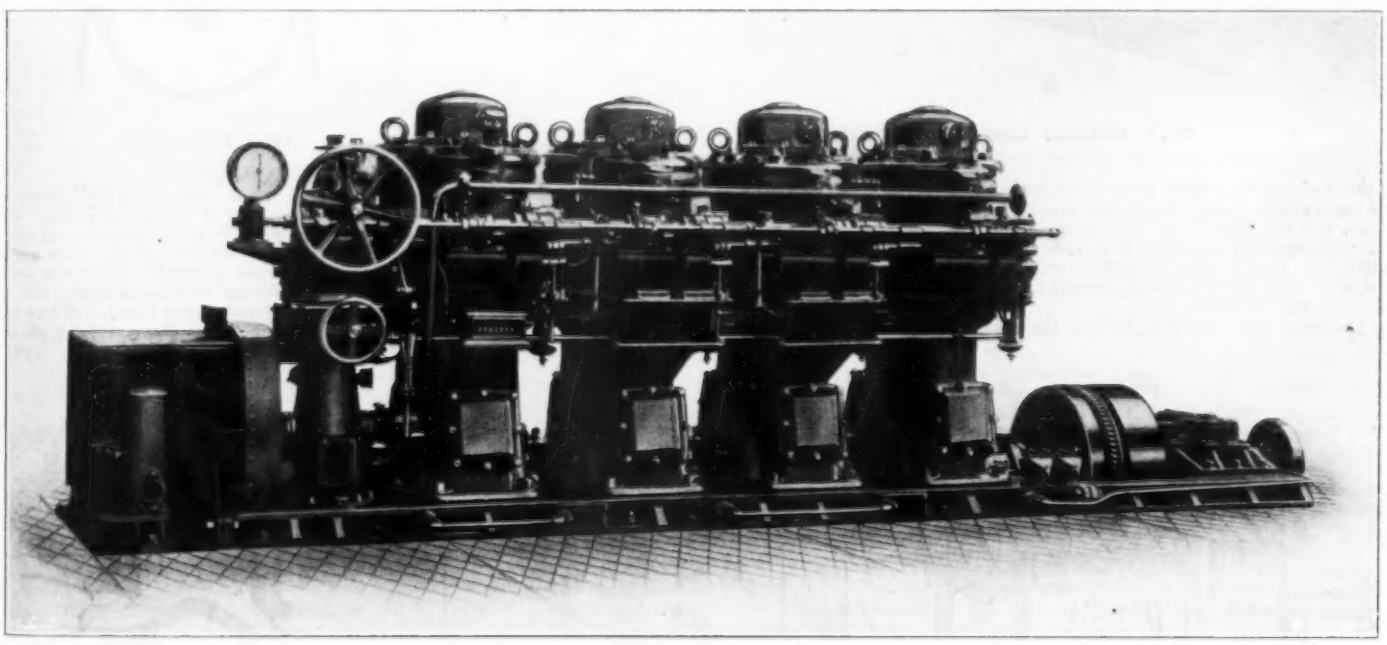


FIG. 1—100 B.H.P. LOW COMPRESSION, TWO-STROKE CYCLE, HEAVY OIL ENGINE—VICKERS-PETTERS

of interest. Fig. 3 shows in diagrammatic form the complete fuel system for a single-cylinder engine. In multi-cylinder engines there are separate fuel pumps and injection systems, with a common governor control. The fuel oil is fed from the storage tank through an oil heater—if required—to the suction valves of the fuel pump. The fuel pump plunger A is operated by the lever B, which receives its motion from the fuel cam C, which is mounted adjustably on the main crank shaft. The stroke of the pump is constant, but the amount of fuel sprayed into the cylinder through the atomiser D is determined by the governor, which opens a control valve before the end of the pump stroke and by-passes the surplus fuel back to the fuel tank.

The governor unit—see Fig. 3—is of the standard centrifugal type, and is bevel-gear driven from the crank shaft. As the speed of the engine increases and the weights move outwards, the motion is transmitted through the governor lever F and the link rod G, and is made to rotate the helical cam plate H. The adjusting set screw K on the control valve tappet lever I is arranged so as to make contact with the control valve spindle of the fuel pump. The clearances are so arranged that after the fuel pump plunger has travelled a portion of its stroke, the control valve comes into action and cuts off the flow of fuel, which otherwise would have been delivered to the atomiser. The position of the stroke at which cut-off takes place is varied by the governor, which thus keeps the speed of the engine constant under a varying load. On its way to the atomiser the fuel passes through a special pipe line strainer, and another auxiliary strainer is fitted in the atomiser itself. The fuel is sprayed by being passed through a nozzle, in which holes of a fine gauge are drilled. The action of the valve is fully automatic and the needle valve is held in its seat by means of a spring, the load exerted by which can be adjusted. The spring is usually set so that the valve opens with a fuel pressure of about 800 lb. per square inch. A small amount of fuel oil is allowed to leak past the needle valve spindle, and serves to lubricate it, any excess of oil being drained back to the fuel tank by a pipe coupled to the end of the atomiser. In order to stop the engine a special valve is fitted in the fuel pipe line between the pump and atomiser. By opening this valve, all fuel oil delivered by the pump is by-passed to the fuel tank, and the engine deprived of its fuel immediately shuts down.

Other interesting details are those connected with the starting of the engine. The single-cylinder engines are fitted with a hand-starting valve, and all multi-cylinder engines are provided with the mechanically operated starting valve system, illustrated by drawing Fig. 6. It will be seen that the starting cam is mounted on the crank shaft, and by means of a movable starting lever it transmits motion to the starter valve designed to admit compressed air into the engine cylinder. At the cylinder itself an automatic non-return valve is fitted. When the starting handle is placed in the starting position, the lower valve is held open during the portion of the stroke over which starting air is required, and the air enters the cylinder through the inlet valve. When the handle is moved into the running position, the starting lever is put out of action, and the valve remains closed. Another aid to quick starting is the rapid-starting burner shown in Fig. 4. The burner takes its oil supply from a special paraffin tank, and air for combustion is taken from the main starting air receiver at 20 lb. to 25 lb. per square inch pressure. The flame of the burner is directed on to an ignition

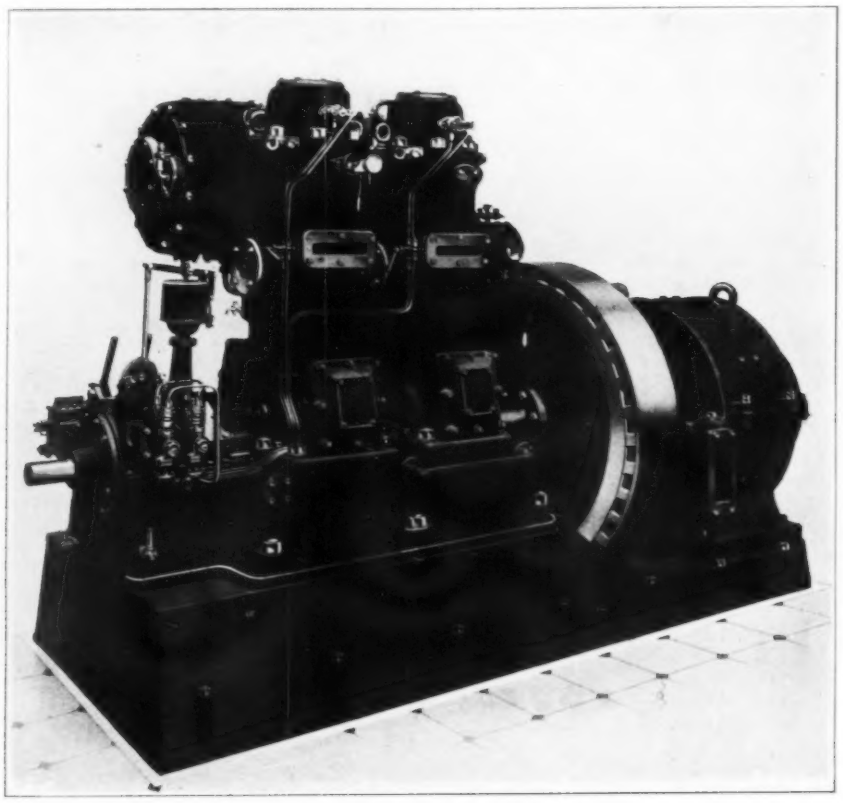


FIG. 2—AUXILIARY LIGHTING SET—VICKERS-PETTERS

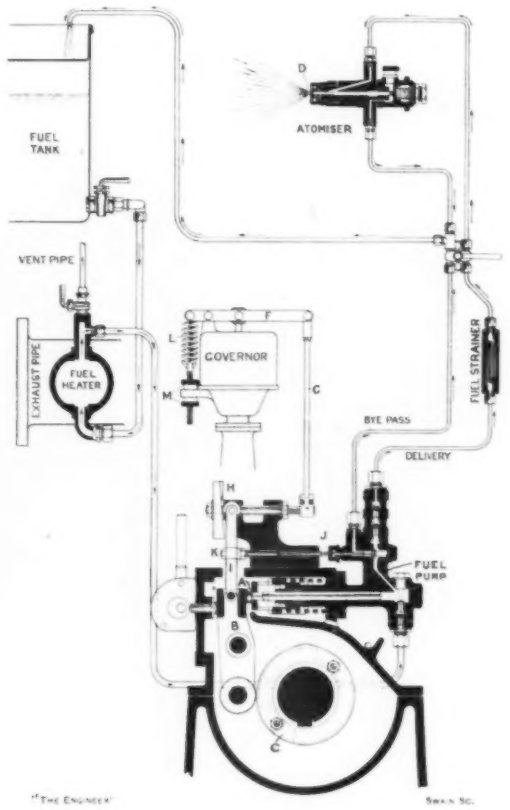


FIG. 3—FUEL SYSTEM

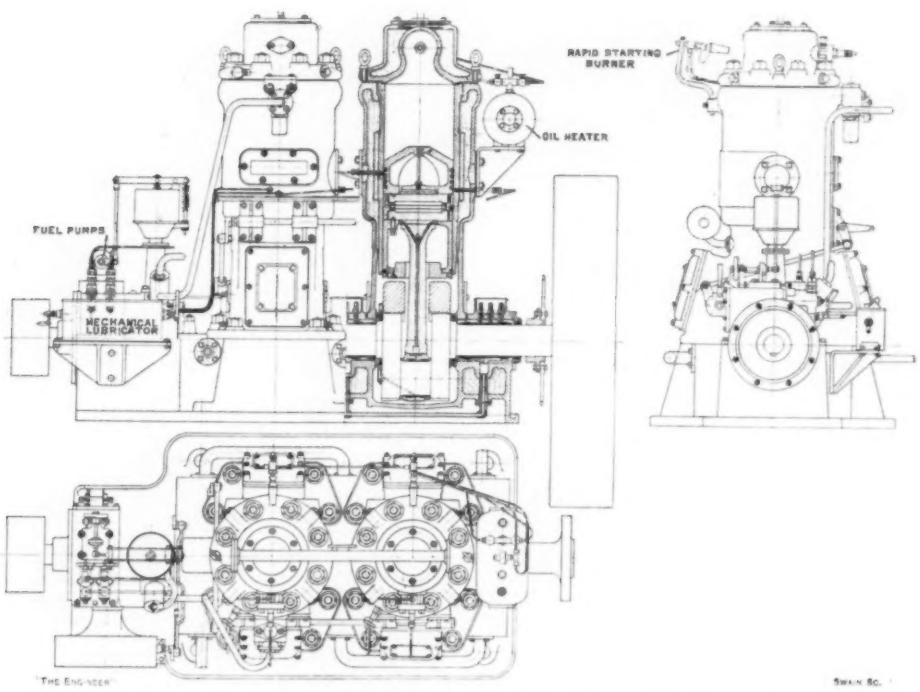


FIG. 4—70 B.H.P. HEAVY OIL ENGINE—VICKERS-PETTERS

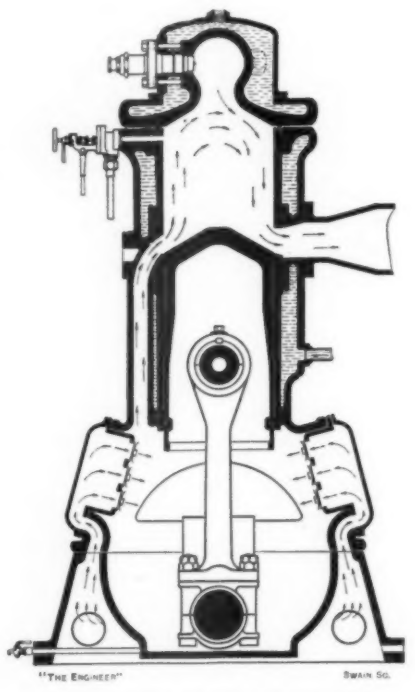


FIG. 5—CROSS-SECTION OF ENGINE

tube, fitted into the cylinder head almost opposite the fuel atomiser. An alternative method of furnishing the additional heat which ensures good and quick combustion for the first few injections of fuel during the starting period is to use a low-voltage electric heating plug. Such a device takes the place of the burner and the ignition tube, and it can readily be operated from a battery and a small charging dynamo. The illustration Fig. 7 shows one of these plugs. It consists essentially of a heat-resisting body, which is screwed into a pocket in the cylinder head. A central electrode passes through the body and is insulated from it by mica washers, and is secured by a gland nut. The heating coil is connected between the central electrode and the plug in a simple mechanical manner.

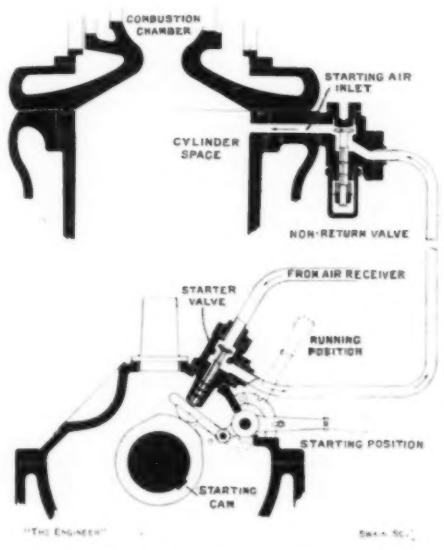


FIG. 6—STARTING SYSTEM—VICKERS-PETTERS

When current is passed through the coil, it is raised to a glowing heat in about half a minute. Each plug is designed to take about 30 to 35 ampères at a pressure of 4 to 6 volts. The electric heating plug is fitted opposite the atomiser, so that the fuel sprayed to the centre hole in the atomiser nozzle is directed right on to the heated coil.

From tests which have been made with the "C" type engine we learn that the fuel consumption at full load varies from approximately 0.43 lb. of oil fuel per brake horse-power hour in the larger sizes to slightly higher consumptions in the case of the smaller sizes of engines, whilst the amount of lubricating oil used is reported to be approximately 50 per cent. less than that used in the

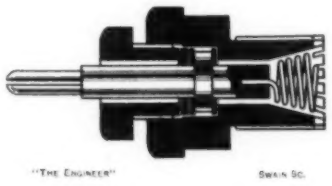


FIG. 7—ELECTRIC HEATING PLUG

ordinary type of hot bulb motor or in a well-made four-stroke cycle engine of a corresponding horse-power.

Kelvin, Bottomley and Baird, Ltd.

A very wide range of interesting exhibits is to be found on the stand of Kelvin, Bottomley and Baird, Ltd., of Glasgow. Of the devices and instruments invented by the late Lord Kelvin, several are shown in the forms which they have assumed with the passage of years. Among the other exhibits on the firm's stand is Boulton's patented "econometer" for analysing flue gases for their carbon dioxide content. The device shown diagrammatically in Fig. 8 consists of an inner and outer metal casing packed with cork, and containing a water jacket surrounding two chambers A and C, one containing any convenient dry absorbent, and the other a piston provided with a graduated stem. The chambers A and C communicate with each other at P and Q. An inlet R and an exit S are arranged in connection with the chamber C, and a sensitive manometer M is fitted as indicated. A valve, not shown, controls the passages P, Q, R and S. With the piston at the bottom of its stroke and the passages P Q closed, a charge of the gas to be sampled is drawn in through the inlet R, the outlet S meanwhile being open to the atmosphere. With the piston at the top of its stroke, the passages R S are now closed and the passages P Q opened. The piston is then moved down and up once or twice, and the gas as a consequence is caused to circulate through the absorbent material. At the end of this operation the piston is returned to the top of its stroke. The volume of CO_2 absorbed represents a diminution in the volume of gas originally in the chamber C, and of the air or other inert gas originally in the chamber A. This diminution results in a fall of pressure within

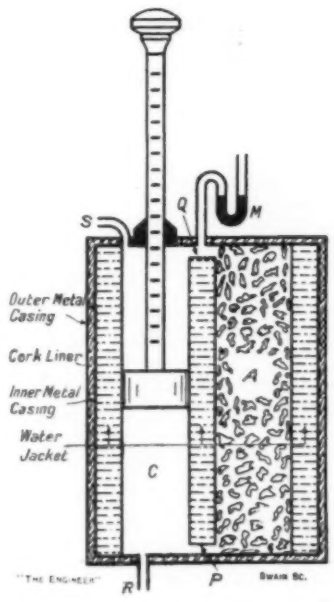


FIG. 8—THE BOULTON ECONOMETER—K.B.B.

the chambers. The piston is therefore lowered until the manometer indicates the original pressure. In this condition the volume of piston-rod introduced into the chamber C represents the amount of CO_2 absorbed, which amount can be read off as a percentage on the graduated rod. The precautions taken

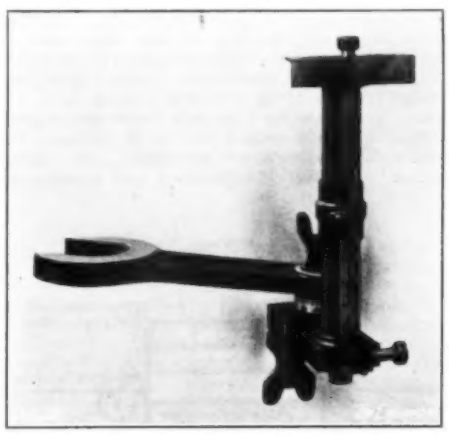


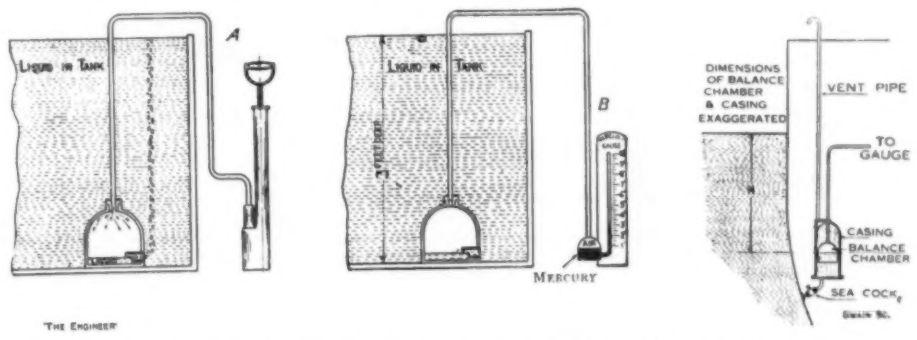
FIG. 9—THE VIBROMETER—K.B.B.

to insulate the chambers are designed to prevent the pressure of the gaseous contents from being influenced during a test by outside sources of heat. It is claimed that the device, with ordinary care, can indicate the CO_2 percentage in a sample to within a quarter of 1 per cent.

The vibrometer—Fig. 9—another of the firm's exhibits, is intended for the detection and investigation of vibration produced in or by high-speed turbine or other machinery. Its action is based on the resonance of a thin reed, which is weighted at the top and clamped at the foot, and restrained intermediately by means of an adjustable clamp on a graduated pillar. On top of the pillar and at right angles to it, a scale is fixed, whereby the amplitude of the free end of the reed, when vibrating, can be measured. The pillar can be rotated about a vertical and a horizontal axis, both motions being provided with scales. The whole device is carried by a spanner-like arm, the end of which can be fixed under a nut on the machine, the vibration of which is to be investigated. With the adjustable clamp in its lowest position, the instrument is set up in such a way that the spanner arm is at right angles to the shaft of the machine under test, the pillar vertical and the amplitude scale parallel with the spanner arm. In this condition the adjustable clamp is moved upwards on the pillar until the reed is vibrating with its maximum amplitude. Should the vibration of the machine under test not have its maximum value in the horizontal plane, the amplitude of the reed will be found to increase when the pillar is rotated about its vertical or horizontal axis, or both. When the maximum amplitude is found, the edge of the amplitude scale at the top of the pillar will indicate the direction of the maximum resultant vibration. From the free length of the reed, as measured against the scale on the pillar, the frequency of the vibration can be deduced, and by the amplitude of the loaded end a measure of the magnitude of the vibration is afforded. The instrument weighs 2 lb., and it is claimed that its mass is not sufficient sensibly to affect the existing vibration in the machine tested or to introduce any lag.

FIG. 12—HEATING AND VENTILATING UNIT—K.B.B.

A new type of heating and ventilating unit for ship's cabins is exhibited by the firm, and is illustrated in Fig. 12. Each cabin is equipped with one of these units, which is under the individual control of the occupant. The unit consists of an electric heater, and an electrically driven fan drawing its air supply through an opening in the cabin bulkhead. The switch has four positions giving:—Fan off; fan on, cold air; fan on, low heat; fan on, full heat. The arrangements are such that the heater cannot be set to work unless the fan is running, a precaution which prevents waste of energy and renders impossible the overheating of the apparatus. The delivery nozzle shown in the engraving is adjustable by the occupant to permit the fresh air to be delivered in various directions. In most cases, nothing more than a 5in. hole in the cabin bulkhead is required for the installation of the unit. The electrical energy required is obtained from the ship's electric light mains. Contrasted with the usual group system of heating, the unit system, the makers claim, economises in initial and running costs by avoiding the necessity for the provision of expensive trunking, which often requires the ship's structure to be cut away exten-



FIGS. 10 AND 11—PNEUMERCATOR TANK GAUGE AND DRAUGHT INDICATOR

sively, and by providing individual control. thereby avoiding compulsory use and reducing stand-by losses. In addition, the system, it is stated, economises weight and is noiseless in operation.

Since the "Pneumercator" tank gauge was introduced some six or seven years ago, it has been considerably developed, and its applications extended. When we first saw it at the Glasgow Engineering Exhibition in 1919, its primary object was to enable the level of oil in a fuel tank afloat or ashore to be read accurately on a gauge situated at any distance from the tank. It has now been developed, not only to measure the quantity of any kind of fluid in a tank—such as ammonia or acid in the tanks of a chemical works—but also to measure the draught of a ship, the depth of a river, the state of the tides, the depth of water in a dock, and in many other directions. A particularly interesting application is the use of the system for reading at any distance the level of water in a boiler or group of boilers.

The system consists of a balance chamber placed at the bottom of the tank and connected by any length of small solid-drawn air piping to a control valve, whereby the chamber may be placed in communication with an air pump—Fig. 10, A—or with a graduated mercury gauge—Fig. 10, B. The balance chamber is provided with a sharp-edged orifice, the level of which forms the datum line for the measurements. When the gauge is being graduated, allowance is made for the height at which the orifice edge stands above the tank bottom. When a measurement is required, the pump is given a few strokes to drive the liquid in the balance chamber down to the level of the sharp edged orifice. Excessive pumping merely results in the surplus air being expelled through the orifice to escape by bubbling upwards and does not affect the reading obtained. With the balance chamber charged with air to its full capacity, the air pressure inside the chamber is that corresponding to the static head of the liquid in the tank. When therefore the control valve is operated to connect the balance chamber with the mercury gauge, a reading of this pressure is obtained on the gauge. From a knowledge of the specific gravity of the fluid in the tank the gauge can be scaled to read this pressure in terms of depth of fluid. If the tank has parallel sides, the pressure may be converted into terms of weight independently of the specific gravity of the fluid, a method of working of great value when the fluid is one which changes its specific gravity with change of temperature. The reading given by the gauge is at all times independent of the temperature of the air in the connecting pipe line. It is of interest to note that the system gives an indication of the fact when the contents of a tank become frozen. In such circumstances, repeated operation of the air pump results in gradually increasing readings on the gauge. The gauge may be connected to an annunciator operated electrically by the mercury column and indicating predetermined maximum, minimum or other levels.

If the tank is under pressure or vacuum, the top of the mercury column of the gauge is permanently connected by a small pipe to the space above the liquid in the tank. The method of applying the "Pneumercator" system to a ship for measuring her draught is illustrated in Fig. 11. Due allowance is made when the gauge is being graduated for the height of the sharp-edged orifice above the keel level. There may be one balance chamber forward and one aft, connected to two gauges placed side by side at any convenient point on the ship. Alternatively, the mean draught of the ship may be obtained from a balance chamber placed at the middle of her length. In this case the gauge may be graduated to read directly in terms of tons displaced.

The "Pneumercator" distant boiler water gauge represents a development which is perhaps best considered as a separate invention. A "datum chamber"—A, Fig. 13—provided with radiator fins is connected at B to the steam space of the boiler, and by two pipes C D to a divided header E from which rise two sight glasses F G, connected by a second header H at the top. The pipe D is joined at J to the water space of the boiler. Inside the chamber A a sharp-edged weir is situated at a point between the outlets to the pipes C D. By the operation of the various valves attached to the parts, the system can be charged with water with a small quantity of air trapped in the header H and the upper portions of the tubes F G. As originally primed, the water rises in the tubes C D to the level of the water inside the boiler. Subsequently, however, radiation from the chamber A causes steam to condense therein, with the result that water collects in the pipe C and the chamber A up to the level of the top edge of the weir. The water formed by any additional condensation returns to the boiler down the pipe D, the level in which remains at the boiler water level. It is clear that no matter where or at what distance from the boiler the gauge is situated, the difference of level of the water in the columns F G will reproduce the distance of the boiler water level from the level of the weir edge in the chamber A. Consequently, the reading afforded by the columns F G replaces the reading of an ordinary gauge fixed to the boiler between the points B J. A change in the boiler pressure does not affect the difference of level in the columns F G, for the two levels are influenced equally by any expansion or compression of the air trapped at the tops of the columns, and in the header H. A change in the boiler pressure does, however, affect the position of the scale on the gauge. Thus, a rise of pressure compresses the trapped air and causes the levels in the two columns to rise through equal amounts. Means are therefore provided for adjusting the zero of the scale against the level of the water in the column G. This movement of the scale to meet variations in the boiler pressure can be greatly reduced or rendered, practically speaking, quite superfluous by making the column G of large diameter. Moderate changes of boiler pressure, as a result, produce a negligible change in the level inside this column. The tube F is an ordinary gauge glass, but the tube G, because of its size, is made of metal. The level in the tube G has therefore to be read on a sight glass K, communicating with G and the header H. It is claimed for this gauge that it not only permits the boiler level to be read at the most convenient point, but that it enables gauge glasses to be used under conditions of temperature and absence of surging which are such as greatly to prolong the life of the glasses.

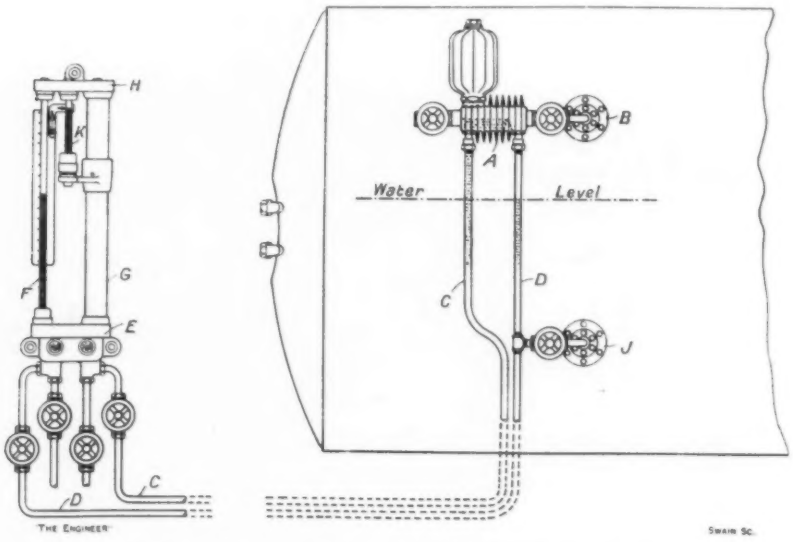


FIG. 13—PNEUMERCATOR DISTANT BOILER WATER GAUGE—K.B.B.

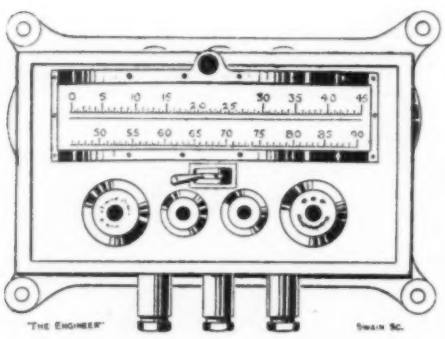


FIG. 14—BEHM TIME-INTERVAL RECORDER

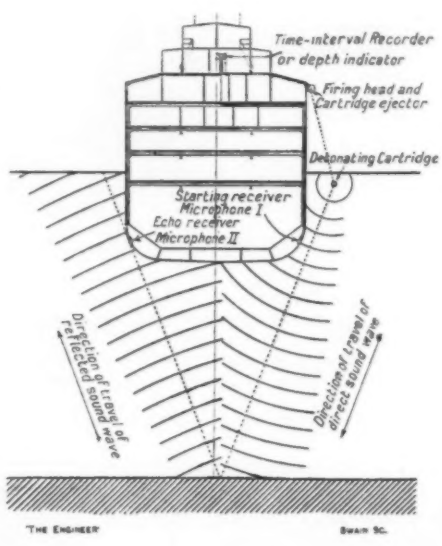

Time-interval Recorder or depth indicator
Firing head and Cartridge ejector
Detonating Cartridge
Starting receiver Microphone I
Echo receiver Microphone II
Direction of travel of reflected sound wave
Direction of travel of direct sound wave
"THE ENGINEER"
SWAIN SC.

FIG. 15—BEHM ECHO-DEPTH-SOUNDER

Of all the exhibits on Messrs. Kelvin, Bottomley and Baird's stand, none is likely to attract greater general interest than the Behm echo-depth-sounder. This device, the invention of a German physicist, Herr Behm, of Kiel, is designed to enable soundings to be made at sea by noting the time interval taken by a sound to travel from the surface to the bottom and thence to return as an echo. The true basis of the invention is an instrument—Fig. 14—capable of measuring intervals of time down to the thousandth part of a second. This instrument is placed at any point on the ship and is connected to a firing head and two microphones. When the firing head control on the instrument is operated, a cartridge is ejected from the ship's side. This cartridge is fitted with a delay action fuse, and explodes when it has descended through a few feet of water. The noise of the explosion is caught by one of the microphones, which operates a relay that starts the action of the time interval recorder. The echo from the bottom is shortly afterwards received by the second microphone, which acts to stop the recorder. From the known velocity of sound in water, the scale of the recorder may be graduated to read directly the sounding in feet or fathoms. From Fig. 15 it will be gathered that the two microphones are placed low down inside the hull on opposite sides, and that reliance is placed on the shielding effect of the hull to prevent the echo-receiving microphone from operating under the influence of the sound of the explosion, which sets the starting microphone to work. In some instances such shielding action is not available or cannot be relied upon. When such is the case, the echo-receiving microphone is fitted with an arrangement which momentarily throws it out of action when the cartridge is fired. The device is applicable to soundings or measurements vertically or horizontally in water or in air. It was employed, we understand, during the trials of the reparations Zeppelin airship Z R 3 before she left Germany, and gave a satisfactory account of itself when the vessel was travelling at all speeds up to 62 miles an hour.

Boulton and Paul, Ltd.

As at previous shows, the most impressive exhibit on the stand of Boulton and Paul, Ltd., of Norwich,

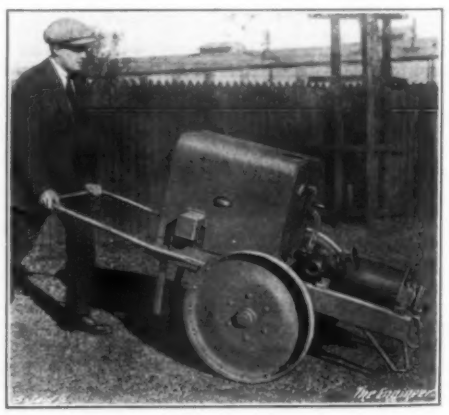


FIG. 16—PORTABLE PUMP—BOULTON AND PAUL

is a water lifter of the band type, made under the Caruelle patents, but these machines are so familiar to our readers as to need no detailed de-

scription. The big set exhibited is shown at work raising 11,500 gallons of water per hour, and there are also some smaller standard models.

The most novel exhibit on this stand is the Lowrev-Turbo portable pumping set—shown in Fig. 16—which is a development of a portable pump made by this firm for the past fourteen years. It is intended for use as a small fire-engine for factories or country houses, but can, of course, be used for a variety of other purposes. The set comprises a petrol engine directly connected with a turbine pump, and mounted on a two-wheeled trolley, so that it can be easily moved about. The engine is one of the standard units made by the firm, and develops from 4 to 5 horse-power. It has a single cylinder 3¾in. in bore by 4½in. stroke, and runs at 1000 revolutions per minute. The ignition is of the high-tension magneto type, the bearings are lubricated by means of a pump, and there is a Solex carburetter. The pump is of the six-stage type, with a cast iron casing and gun-metal impellers. It will be noticed that the engine is covered with a sheet metal casing, and there is a metal "dash-board" for carrying the petrol tank, pressure gauge and magneto switch. A by-pass on the main pump is used for supplying cooling water to the cylinder jacket. This set will deliver 80 gallons a minute against a pressure of 40 lb. per square inch, and will throw an effective fire jet to a distance of 55ft. through a ¾in. nozzle. The total weight is 700 lb.

Besides the standard 1½ kilowatt Electolite lighting set, the design of which has now been standardised for over six years, and some self-oiling double-acting pumps, there is a new 4 kilowatt Electolite Major set, which is really a two-cylinder counterpart of the smaller engine. In this set the component parts are, as far as is possible, similar to those of the 1½ kilowatt engine, so as to minimise the stock of spares which an agent has to keep.

Henry Hughes and Son, Ltd.

On the stand of Henry Hughes and Son, Ltd., of 59, Fenchurch-street, E.C. 3, one of the principal exhibits is the echo-sounding machine, designed and patented by the Admiralty Research Department, and constructed by Messrs. Hughes under that Department's supervision. This device, while it employs the same principle as the Behm apparatus described above, differs considerably from it in several important details, the chief difference lying in the adoption of an indirect method of measuring the time interval between the sound impulse and the receipt of the echo.

A diagram of the Admiralty system is given in Fig. 17. The sound transmitter A fixed to the bottom of the ship consists of a stainless steel casting, with a diaphragm about 5in. in diameter, turned from the solid cast metal. A gun-metal casing attached to the casting encloses—as indicated in Fig. 18—an electro-magnet, which, when energised, draws a hammer upwards against the compression of a spring. When the circuit is broken, the hammer descends against the diaphragm and causes it to vibrate at a frequency of 1250 per second. The breaking of the circuit is controlled by a one-eighth horse-power motor B running at 1800 revolutions per minute. The speed of this motor is preserved constant within 1 per cent. by a centrifugal friction governor, which is effective even when the supply voltage varies considerably. Through ten-to-one reduction gearing the motor drives the switch C, consisting of a disc with an insulated strip. Three times per second the circuit is broken, each time for an interval of about 0·0025 second, and as a consequence the transmitter diaphragm is struck by the hammer at a regular period of one-third second.

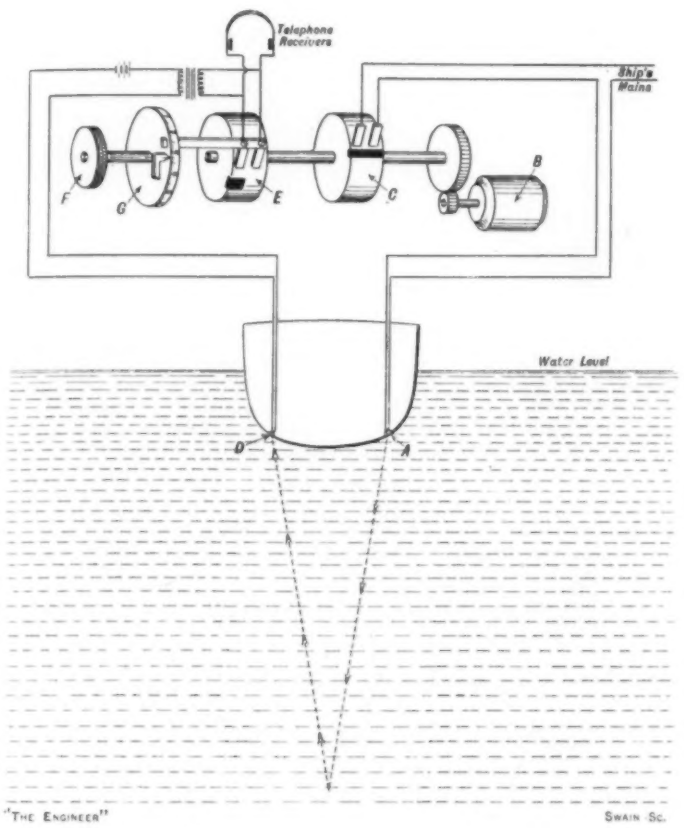


FIG. 17—ECHO-DEPTH-SOUNDER, ADMIRALTY SYSTEM

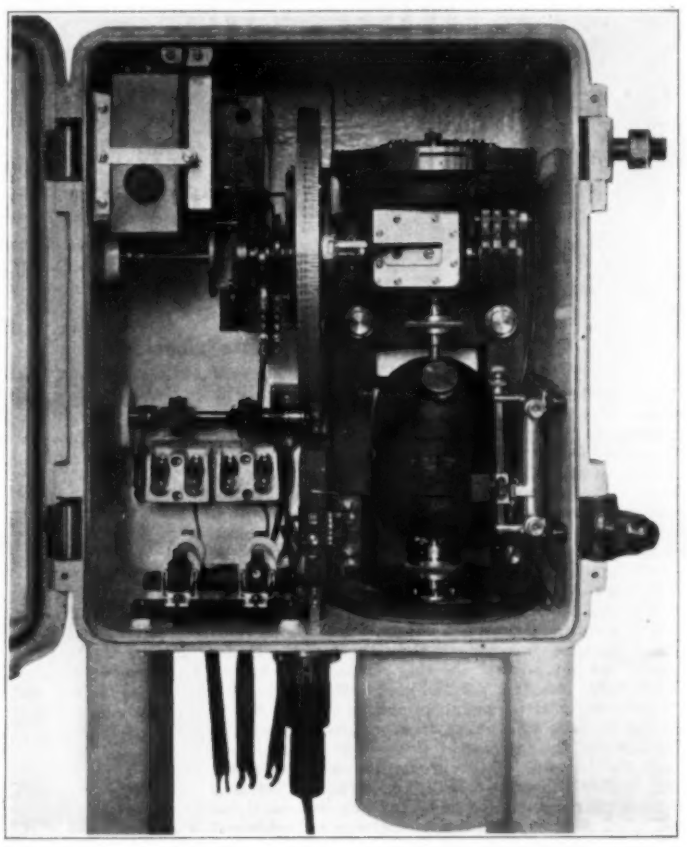


FIG. 19—ECHO-RECEIVING APPARATUS—H. HUGHES AND SON

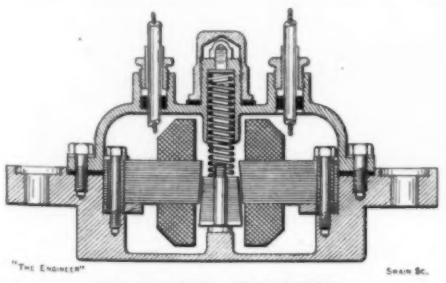


FIG. 18—SOUND TRANSMITTER

On the side of the ship opposite the transmitter is a hydrophone D, of the usual type employed in connection with submarine cables, consisting of a microphone enclosed in a rubber body and immersed in water. The hydrophone is connected through a battery and a transformer with a pair of telephone receivers. By means of a switch E on the same shaft as the switch C, the telephones are short-circuited, except for a brief interval once per revolution, when one of the switch brushes passes across an insulated strip. The brushes of the switch C are fixed in position, but those of the switch E can be moved round the periphery of the switch disc by means of the head F, a scale and pointer G providing a measure of the displacement given to the brushes. It will be seen that no sound will be heard in the telephones unless the switch E opens the telephone circuit at the instant when the hammer descends on the transmitter diaphragm, or at the instant when the echo of the sound so emitted returns from the bottom of the sea. In use therefore the brushes of the switch E are given a positive displacement until the sound of the echo is heard in the telephones. The disc G is graduated to convert the angular displacement of the brushes into a direct reading of the depth in feet or fathoms. The pointer of this scale is adjusted to correct the error—greatest in shallow water—arising from the horizontal separation of the transmitter and the hydrophone. In addition, means are provided for correcting the effect of changes in the draught of the vessel.

In Fig. 19 we give a view of the receiving apparatus as installed in a water-tight case on the navigating bridge. The handle F—Fig. 17—projects outside the case and a glass window in the door enables the scale G to be read. A recording apparatus or repeating gear can be attached to the side of the case. The second-named attachment enables the reading to be repeated automatically in the captain's cabin, chart room or elsewhere, either visually or aurally. A form of lamp receiver has been developed for repeating the reading which consists of a board carrying three vertical rows of nine lamps each. The depth is indicated by the lighting up of one lamp in each row. This lamp receiver is also provided with terminals for an extra pair of telephones, in order that the receipt of the echo may be noted and checked. In Fig. 20 we reproduce a chart taken over a period of about three hours, showing a comparison of the soundings taken with the Admiralty echo gear, and the ordinary lead and line apparatus. It will be noted

DIAGRAM SHOWING COMPARISON OF SOUNDINGS OBTAINED

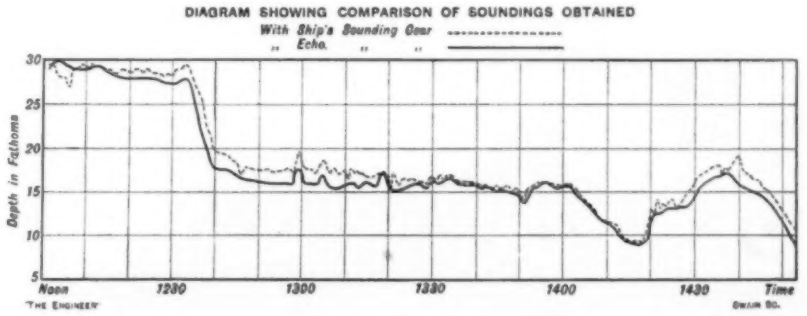


FIG. 20—COMPARISON OF SOUNDINGS

that in general the echo gear gives a lesser depth than the ordinary apparatus, and therefore that any error in its readings is, if anything, on the side of safety.

CLEWS PETERSEN COMPANY.

One of the most interesting features about the piston rings exhibited by the Clews Petersen Piston Ring and Engineering Company, of West Heath

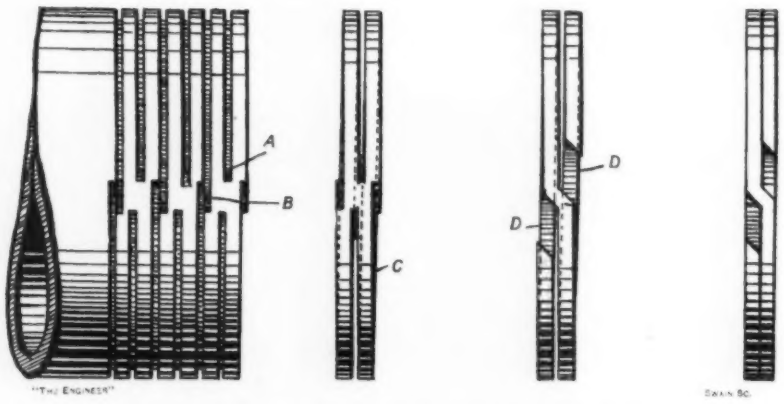


FIG. 21—METHOD OF MAKING CLEWS PETERSEN PISTON RINGS

Works, Mill-lane, West Hampstead, is the process by means of which they are manufactured. Each of these rings is in the form of a double coil round the circumference of the piston, so that the possibility of leakage at the joint is minimised as far as is possible. The rings are cut from an ordinary pot casting, in the lathe, but instead of parting them off in the usual manner, the tool is given a slight travel, so that when the pot has made one revolution the front edge of the parting tool is opposite the rear edge of the start of the cut—as illustrated at A in Fig. 21. A relieving device then comes into operation, and the tool is withdrawn during a short part of the revolution. The groove is not cut right through the thickness of the pot, so that the ring remains attached to the casting. Another parallel groove is next cut, but the relieving gear is put out of action, and the end of the cut is made to overlap the start—as shown at B. Then, when the interior of the pot is bored out to meet the bottoms of the grooves, a series of rings, such as that shown at C, will be produced. The ring is next placed in a jig and gaps are cut in it, as indicated at D D, so that it emerges as a double coil helix with a sharp step or bridge opposite the two ends of the coil. The faces of the bridge and ends are so aligned that when they are closed together a close-fitting joint is made. The two coils of the helix are, however, open to the extent of the width of the parting tool. For this reason the two ends of the coil are threaded past the middle turn, in opposite directions, so that the helix is inverted. In this condition any arris left by the parting tool can be easily removed. The ring is then pulled open axially to give it a slight permanent set, and is finally re-inverted. The set then has the effect of keeping the parted faces tight together. It will be readily appreciated that these rings are much more likely to make a gas-tight joint than are the old-fashioned single-coil rings.

LAURENCE, SCOTT AND CO., LTD.

The Donkin Scott direct-acting electric steering gear—as shown in Fig. 22—is one of the exhibits of Laurence, Scott and Co., Ltd., of Norwich, but as this gear has already been described in THE ENGINEER we need say little about it, beyond the fact that its outstanding advantage is that no make and break of the current takes place during its operation, for the gear is worked by promoting and stopping the flow of current in the permanently closed circuits. An important advantage of the system therefore is that no sparking and burning of the contacts can occur. The first equipment was installed on the Mississippi of the Atlantic Transport Line in 1914, and it has been in continuous operation ever since.

The speed control of series wound motors for crane and lift work has always been a somewhat difficult problem, and in this connection the Scott patented floating brake system is of considerable interest. A crane motor with the necessary arrangements fitted is shown in Fig. 24. Laurence, Scott and Co. contend that no simple method has hitherto been developed for controlling the lifting speeds of crane and lift motors at light loads and the lowering speeds at all loads in an entirely satisfactory manner. All the difficulties of the rheostatic braking system and the potentiometer system are said to have been overcome by the use of a combined electro-magnetic and mechanical control system. The disc type of brake on which this floating brake system is based has proved, it is claimed, a marked success in ships' deck winches. The brake is controlled by a small shunt winding, which is used for full lifting and lowering, and a heavy series winding, which when energised attracts the steel armature against the pressure of springs, thus taking off the brake. The "floating" or slow speed steps of the controller, with the starting resistance in circuit, are arranged to divert current from the series winding of the brake to such a degree that the pressure of the springs begins to overcome the opposing magnetic force and partially applies the brake. In this condition the brake is floating; the speed of the motor depending upon the amount of current diverted from the series winding of the brake. The floating action of the brake on any braking step of the controller is nearly independent of the amount of load lowered. The action is self-corrective—so much so, in fact, that the braking surfaces can be treated with plumbago, so as to diminish the coefficient of friction without appreciably affecting the speed control effect of the brake. The automatic floating action of the brake is said to be remarkably even and steady, for if the friction of the brake increases the current taken by the motor, and therefore that in the brake coil, also increases, with the result that the brake is slightly eased. If, on the other hand, the friction decreases, the current in the brake coil decreases, and the braking action automatically increases. The action is, therefore, self-corrective, and the lightest and heaviest load can be lowered gently to the ground. For wharf and similar cranes having long lifts this brake is usually combined with a centrifugal brake, which prevents excessive speed when lowering all loads.

A barrel type starter combined with an electric motor—as shown in Fig. 25—is another of Laurence, Scott and Co.'s exhibits. As these starters are fitted with a free handle overload device, they are equivalent electrically to the usual combination of starter with a separate overload circuit breaker, but they are more compact. They are entirely constructed on the metal and mica principle, and all the connections are visible, and may easily be attended to from the front of the starter. In the event of a failure of the supply the barrel of the controller returns automatically to the off position under the action of a spring. The circuit breaker is operated by a cam on the barrel through an arm and catch, which form part of the

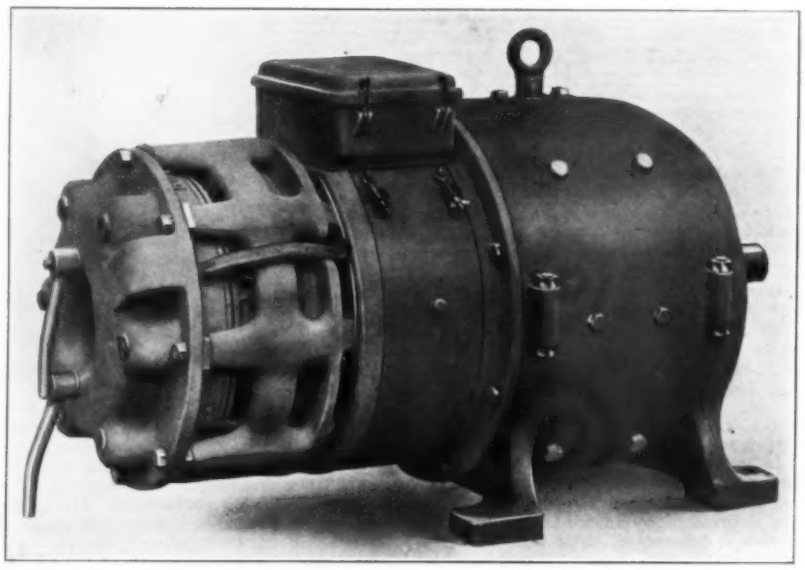


FIG. 24—CRANE MOTOR WITH FLOATING BRAKE—LAURENCE, SCOTT AND CO.

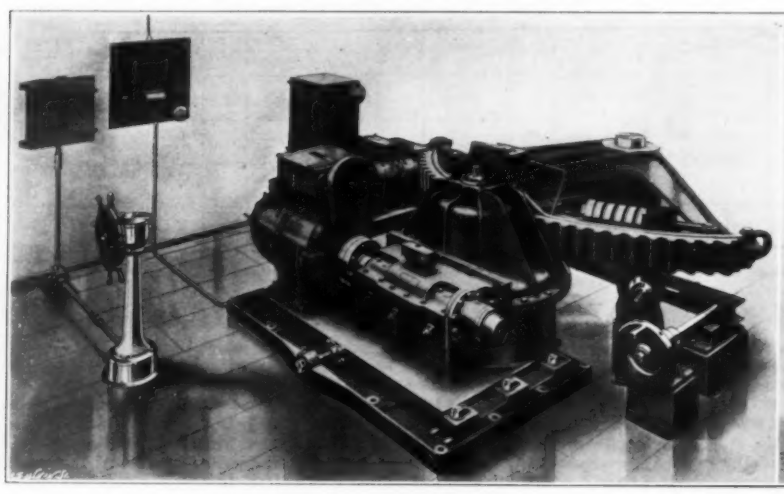


FIG. 22—DONKIN SCOTT ELECTRIC STEERING GEAR

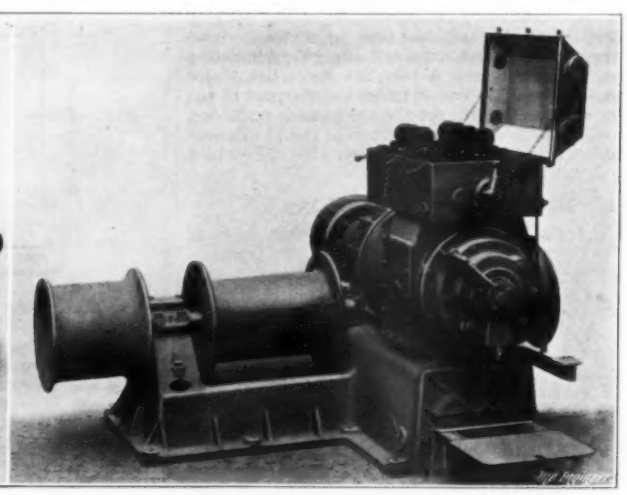


FIG. 23—ELECTRIC WINCH—LAURENCE, SCOTT AND CO.

overload device. This circuit breaker is connected in circuit with the opposite pole to the barrel, and is arranged to close just after the first step on the barrel and to open just before that step, so that the make and break always take place on the breaker and under the action of a powerful magnetic blow-out. An overload trips the catch which holds the circuit breaker, irrespective of the position of the hand wheel, so that it is impossible for the operator to prevent the circuit being broken at times of overload. In the case of the smallest controllers the barrel itself

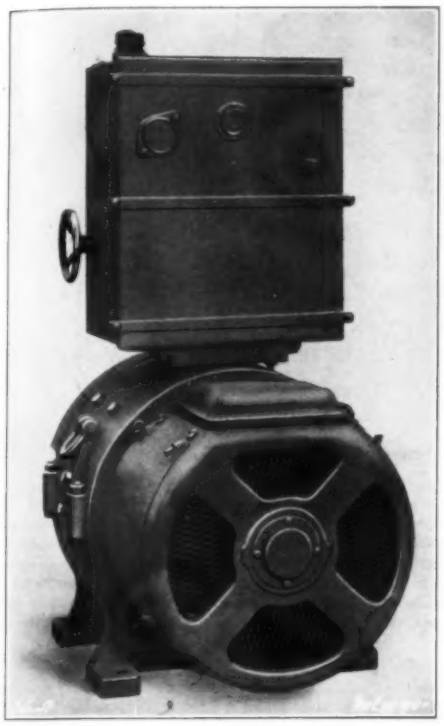


FIG. 25—MOTOR AND STARTER—LAURENCE, SCOTT

forms the circuit breaker, but it is able to fly back independently of the hand wheel when it is released by an overload. These starters are of the single pole type, but all the others are double-pole starters, as described above. As shown in the drawing—Fig. 26—steps can be provided on the barrel for shunt regulation, and these steps are arranged to follow in rotation after the starting steps, so that the motor always starts with a full field. The no-volt device is made to hold the barrel at any one of these steps.

A typical electric winch, as shown by Laurence,

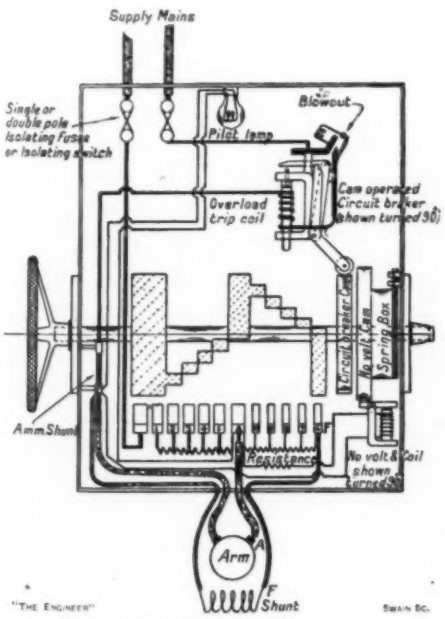


FIG. 26—BARREL TYPE MOTOR STARTER

Scott and Co., is illustrated in Fig. 23. The makers claim that this is the only electric winch in which the whole of the working parts, including all the brake gear, are enclosed and water-tight. There are no rubber joints, and in order to prevent rusting all cover studs are made from brass or phosphor-bronze. Contactor control gear is combined with the winch, the controller being enclosed in a water-tight case on the winch, whilst the resistances are housed in the winch casing. The only wiring required consists of two cables from the engine-room to the winch. If preferred, however, the main controllers may be fixed all together in the deck-house or below deck, the master controller being on the winch. The Laurence Scott contactor control gear is said to have proved a great success on a large number of ships. The speed at which the resistances are cut out cannot be increased to a dangerous value by the manipulation of the hand wheel, and it is possible for unskilled men to operate the winches successfully.

The Cambridge Instrument Company.

Among the exhibits of the Cambridge Instrument Company, of 45, Grosvenor-place, S.W. 1, are combined CO_2 and CO indicators and recorders, draught and pressure gauges, apparatus for the measurement of temperature, automatic temperature regulators, electrical testing sets, and various other instruments for mechanical and electrical engineering measurements. The CO and CO_2 indicators operate on the electrical principle which does not call for chemical absorbents or fragile glass work. Since the instruments are robust and need little attention, they are well suited for use on board ship. There are indicating, recording and combined indicating and recording outfits for one or more points. A simple indicating outfit consists of a CO meter panel—as shown in Fig. 27—connected to an indicator together with a CO_2 meter, soot filter and aspirator. Current for working the apparatus is obtained from a four-volt accumulator. After passing through the soot filter, the flue gases are washed and cooled by passing them through a bubbler, which forms part of the aspirator, and are then drawn past the CO_2 meter—shown in Fig. 28. This CO_2 meter contains two identical spirals of platinum wire, enclosed in separate cells in a metal block; one cell containing air saturated with water vapour, whilst the other is open to the flue gas. These spirals form two arms of a Wheatstone bridge circuit. When an electric current flows in the circuit the spirals become heated and part with heat to the walls of the cells, their temperature, and consequently their resistance, depending upon the thermal conductivity of the gases surrounding them.

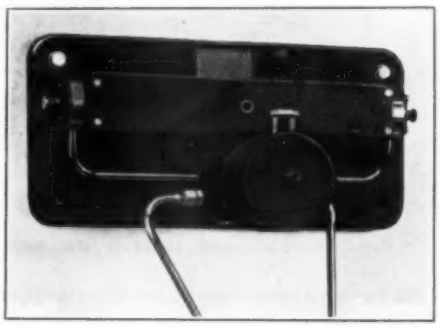


FIG. 27—CAMBRIDGE CO METER AND FURNACE

Changes in the percentages of CO_2 in the flue gas surrounding one of the spirals causes changes in the conductivity of the gas, and consequently changes

FIG. 28—CO_2 METER

in the galvanometer deflection. After passing the CO_2 meter—see Fig. 29—the gases are next directed into one cell of the second meter of similar design to the CO_2 meter, and into a small electrically-heated furnace, where any carbon monoxide present is converted into CO_2, and any hydrogen and methane into CO_2 and water. Finally, the converted gases are passed through the second cell of the second meter and back to the aspirator. The meter therefore measures the increase in the CO_2 content of the gases, caused by their passage through the furnace. This increase depends upon the amounts of CO, hydrogen and methane originally present, and is shown on the indicator scale as a percentage of the combustible gases. As the gas passes in succession through both meters only one soot filter and one aspirator are required. The CO_2 and CO meters are both connected to the indicator shown in Fig. 30. The indicator has two scales calibrated to give direct readings of CO and CO_2 percentages respectively, the standard ranges being 0–20 per cent. CO_2 and 0–10 per cent. CO, and a two-way switch enables readings of either CO_2 or CO percentages to be obtained at will.

When it is desired to measure CO_2 and CO percentages at a number of points, a soot filter, CO_2 meter, and CO meter, together with the other apparatus that is necessary are supplied for each point, but two, or alternatively three points, can be connected to one indicator. This indicator is similar to the single-point instrument, and the multi-way switch is provided with numbered positions corresponding to the various meters and with "off" and "test" positions. Alternatively measurements of CO_2

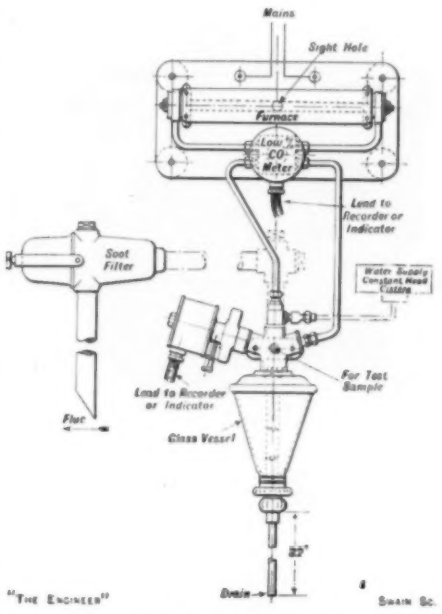


FIG. 29—ARRANGEMENT OF CO AND CO_2 METERS

and CO percentages and of the temperatures of the flue gases at either one or two points can be obtained on one indicator.

A simple recording outfit comprises CO_2 and CO meters, connected by leads to a two-point thread recorder, together with a soot filter, aspirator and an accumulator to provide the current. The recorder consists of a moving coil galvanometer, and its pointer is automatically depressed once every minute on to an inked thread which it forces down on to the chart, fixed on a drum which rotates once in every twenty-four hours. The record is thus traced out in the form of closely spaced dots, and pen friction is entirely avoided. The record for the past few hours

FIG. 30—CO AND CO_2 INDICATOR

is always visible, and the actual reading at any moment can be seen on an engraved scale fixed over the pointer. Two differently coloured threads are brought in turn under the galvanometer pointer, the connections being automatically changed when the thread is changed, and two independent records are thus obtained on one chart. The charts give readings directly in terms of percentages of CO_2 and CO, and the standard ranges are 0/20 per cent. CO_2 and 0/10 per cent. CO. When measurements of CO_2 and CO percentages and temperatures are desired at one point a three-point recorder is supplied. This recorder is fitted with a triple-thread frame, giving three in-

dependent records of different colours on one chart. The mechanism is enclosed in a fume-proof and moisture-proof metal case, which can easily be fixed to a wall or other support. The recorder is also fitted with a push button "test" switch and rheostat, enabling adjustments to be made for any variations in the battery voltage. The metal-cased recorder is particularly suitable for use in boiler-houses and on board ship, as the mechanism is protected from damage. Recorders are supplied to give one, two, four or six records on one chart, and a six-record instrument is shown in Fig. 31.

Dial gauges for the measurement of draught up to pressures of 60in. of water are shown. They can be

FIG. 31—CAMBRIDGE SIX-THREAD RECORDER

arranged to indicate directly the difference in pressure between two points as, for example, above and below the grate of a boiler furnace.

Among other exhibits are examples of the firm's "easy to read" dial thermometers, which are suitable for use in connection with steam and refrigerating plant, &c. They are made to cover various ranges of temperature between the limits of −20 deg. Fah. and + 550 deg. Fah., and on account of the long scale wide and distinct graduations may be employed. An illustration of these dial thermometers, as shown on the company's stand, is given in Fig. 32. The operation of these dial thermometers is dependent upon the expansion, with change of temperature, of

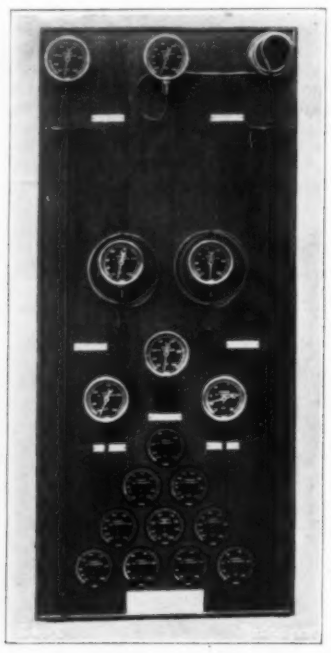


FIG. 32—CAMBRIDGE DIAL THERMOMETERS

vapour from a volatile liquid. The bulb of the instrument is exposed to the temperature to be measured, and is connected directly or by means of flexible tubing to a Bourdon gauge tube, the system being filled with the volatile liquid. Changes in the bulb temperature cause changes in the vapour pressure of the liquid, and the consequent movements of the Bourdon tube are communicated to a pointer moving over a calibrated scale.

PETTERS, LTD.

Petters, Ltd., of Westland Works, Yeovil, have a stand on which there is a representative collection of marine and stationary oil and petrol engines.

The marine exhibits comprise a 16-20 brake horse-power twin-cylinder engine, fitted with an American epicyclic type of reversing gear; another engine of the same class, but of from 24 horse-power to 28 horse-power, and a single-cylinder 8-10 horse-power set. The stationary engines are three magneto-ignition sets of 12-14 horse-power, 18-21 horse-power, and 36-42 horse-power, the latter being the largest size made at the Yeovil works. There

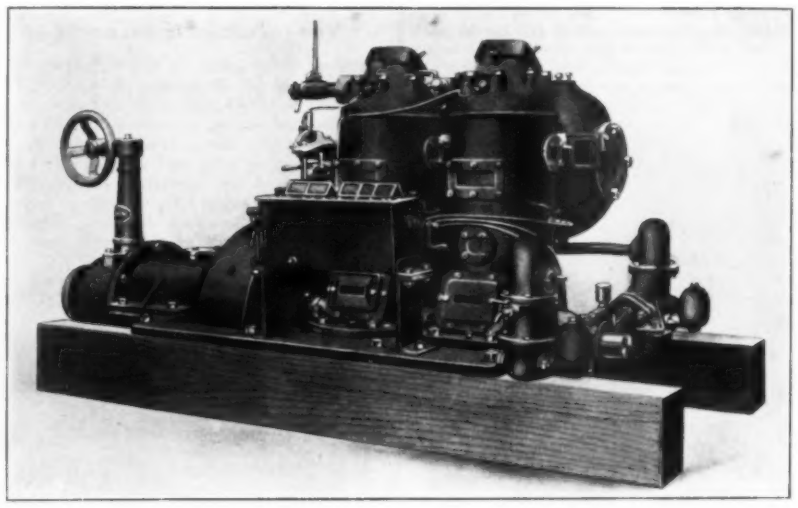


FIG. 33—16-20 H.P. MARINE OIL ENGINE—PETTERS LTD.

are also shown a 5 horse-power engine directly coupled with a 3-kilowatt electric generator; an 8 horse-power marine auxiliary set; a 5 brake horse-power magneto type engine for petrol or paraffin; and one of the new 3 horse-power Handyman agricultural engines. Among the combined sets there are an Alpha-Petter electric lighting plant, an engine driving a force pump, and an 8 horse-power engine working a winch by Clarke, Chapman and Co., of Gateshead.

Of these engines we illustrate—in Fig. 33—the 16-20 horse-power marine set, from which it will be seen that the engine and reversing gear are mounted on one bed-plate. The engine is of the familiar two-stroke hot-bulb type, and is fitted with an electric starting device. This apparatus takes the form of a coil of high resistance wire, which can be projected into the combustion space and raised to a state of incandescence by a current of electricity, so that the first few charges of explosive mixture may be ignited. When the engine has got under way and the cylinder head has warmed up sufficiently to maintain the explosions automatically, the wire coil is retracted into a recess in order to increase its life and the current is cut off. One of the outstanding features about these engines is their ability to run, apparently, indefinitely on light load, a feature which is of great value in a marine engine, as it may be required to be available at a moment's notice for manœuvring purposes, and yet to run idle for long periods while the

FIG. 34—36-42 H.P. STATIONARY ENGINE—PETTERS LTD.

boat is awaiting orders. The mechanical features of these engines have been described before in THE ENGINEER, and thus do not require reiteration. In the case of the single-cylinder, 8-10 horse-power set, however, an innovation has been made in splitting the crank case longitudinally, so that the crank shaft can be lifted out of place vertically, instead of having to be drawn out endways, as was the case with the

previous model. The change has the obvious advantage that the engine can be installed on its bearers close up against a bulkhead with the crank shaft still readily accessible.

The line drawing—Fig. 34—shows a section through the cylinder of the 36-42 horse-power engine, which is of the surface ignition type, that is to say, it is a two-stroke engine with a hot bulb. It has two cylinders 8in. in diameter by 9in. stroke, and runs at 450 revolutions per minute. In order to obviate the

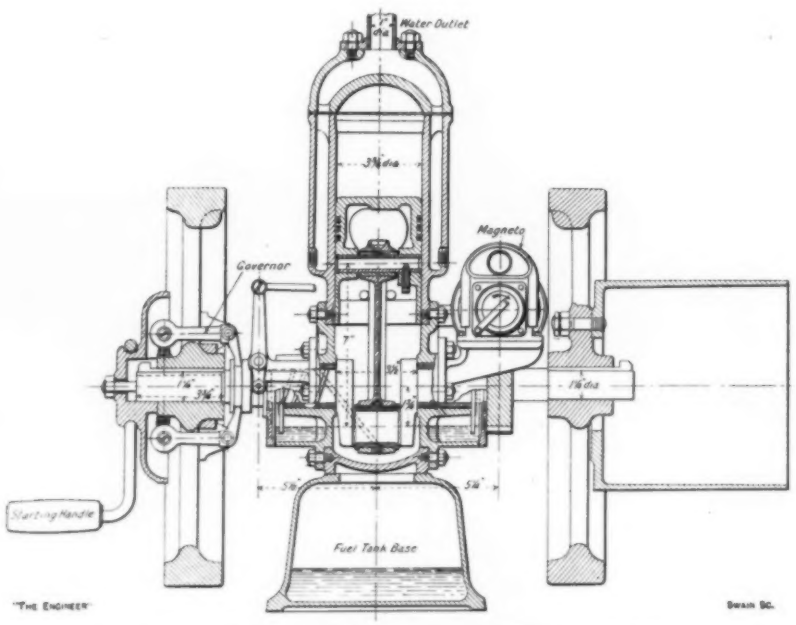


FIG. 35—5 B.H.P. PETROL OR PARAFFIN ENGINE—PETTERS LTD.

delay in starting this class of engine when a blow lamp is used to heat the bulbs preliminary to starting, a special cartridge device is employed. It is in the nature of a firework, which is slipped into a holder and lighted with a match. The cartridge fizzles, like a squib, and is quickly screwed into a hole in the combustion chamber, where it provides sufficient heat to start the first few explosions. It might be thought that the residue from the cartridge would provide material which would score the cylinder; but according to Messrs. Burstall and Monkhouse, the Westminster consulting engineers, it is found, after several

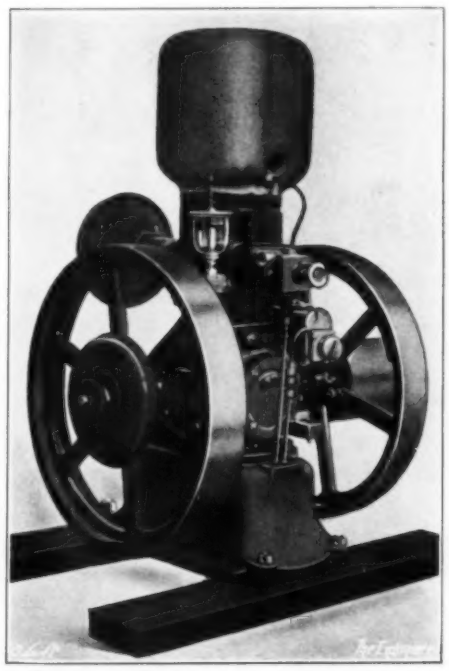


FIG. 36—3 H.P. FARM ENGINE—PETTERS LTD.

successive starts with the cartridge, that the small amount of residue produced is of a wholly innocuous nature. The same engineers have also commented favourably on the ability of the engine to run on light load without any special preparation, and found that it would do so even with a heavy fuel oil having a specific gravity of 0·942. The fuel consumption of these engines naturally varies with the size and the load carried; but in the case of the 12-14 horse-power set, it has been proved to be 0·59 lb. of oil, having a calorific value of 19,460 B.Th.U. per brake horse-power per hour. The lubricating oil consumption is about 0·16 pint per hour.

The engine illustrated in Fig. 35 is the 5 brake horse-power stationary set, fitted with magneto ignition, which is capable of running on either petrol or paraffin. In the case of this engine the main crank shaft bearings are ring lubricated, while the big end of the connecting-rod and the cylinder are lubricated by oil forced up by the compression pressure in the crank case. The surplus oil runs back into a reservoir and is returned for service again. These engines are made in three sizes—of 1½, 3 and 5 horse-power—and run at 750, 700 and 600 revolutions per minute respectively.

The 3 horse-power Handyman agricultural engine—which is illustrated in Fig. 36—has already been described in The Engineer in connection with several other shows, but that exhibited at Olympia is novel to the extent that it is fitted with a new form of silencer. The silencer can be seen, in the illustration, behind the cylinder, and takes the form of two dished castings, somewhat like soup plates. The two dishes are bolted together, face to face, with a distance of about $^{3}/_{16}$in. between the flanges, while the exhaust pipe is screwed to the centre of one. The consequence is that the exhaust is discharged as a thin film which is rapidly cooled by the atmosphere. We have not observed one of these engines running with the new silencer, but are assured that they are as quiet as the older type and show a saving in weight.

In the case of the engine working the Clarke-Chapman winch, there is a countershaft driven off the crank shaft by toothed gearing. On this countershaft there is a pinion meshing with the main gear wheel of the hoisting barrel, and the pinion is connected with its shaft through a friction clutch. The hand lever for controlling the clutch is also connected with the brake, so that it can be used for hoisting or lowering the load, while with the lever in the mid position the engine runs free. In order to provide for lowering the hook with no load there is also a chain drive from the countershaft to the barrel, which is controlled by a separate cone clutch and lever. The barrel arbor is extended beyond the side frame on the end opposite the engine to carry a warping drum.

Clarkson Steam Motors.

The patented thimble-tube boiler, examples of which are shown by Clarkson Steam Motors, 4 and 5, Queen Anne's Chambers, S.W. 1, was originally designed for use on steam road vehicles. A development of later days is the application of this form of boiler for the recovery of waste heat from the exhaust gases of heavy oil engines in land or marine service. In Figs. 37 and 38 we illustrate the Clarkson waste heat boiler supplied for the motor vessel Malabar, a ship fitted with a Burmeister and Wain engine of 2700 brake horse-power. The boiler was not designed to recover the maximum amount of heat from the exhaust, but to serve other needs as well, and in particular to act effectively as a silencer. The feature of the construction of the boiler lies in the provision of the major portion of the heating surface by means of a large number of thimble-shaped tubes which project into the path of the hot gases and which, being staggered, act efficiently in extracting the heat from the gases and in deadening the noise of their escape. It is claimed that the construction of the tubes is such as to prevent the deposit of scale on them, and that the oily soot from the exhaust gases can be readily removed by combustion. The circulation of the water in the tubes follows a pulsating action, which helps to keep the tubes clean. That there is a circulation, and that it is efficient, is evidenced by the fact that the tubes are not burned, even, the makers state, under the most intense firing.

On the M.S. Malabar the quantity of heat required for the steam ovens, cooking boiler, hot water boilers, hot presses, geysers and hot water mixers was estimated not to exceed 400,000 B.Th.U. per hour. Tests made on October 8th this year under the supervision of Board of Trade and Lloyd's surveyors showed that the actual amount of heat recovered from the exhaust gases was about 2,000,000 units per hour. The surplus 1,600,000 units are available for other services, such

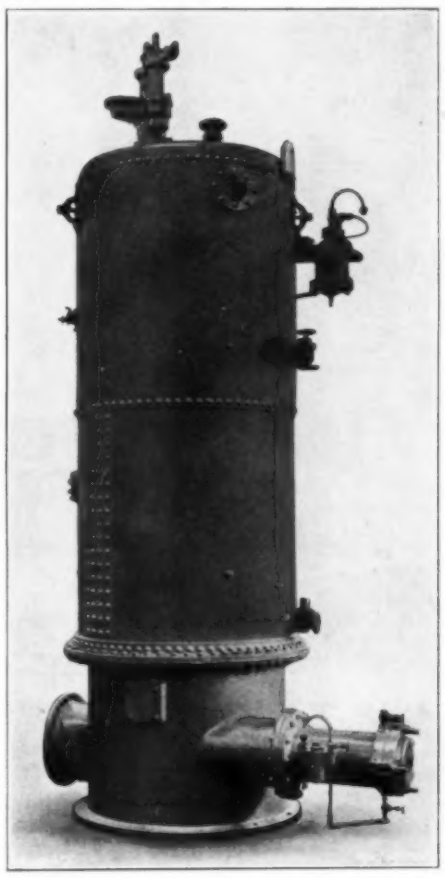


FIG. 37—CLARKSON WASTE HEAT BOILER

as operation of the whistle, evaporation of salt water and auxiliary power. It is to be noted that the main engine is fitted with a water-cooled exhaust manifold which naturally reduces the temperature of the waste gases supplied to the boiler. It is therefore obvious that were it desired an increased amount of heat could be recovered from the exhaust of the Malabar's engines.

During the tests of the boiler, according to a report with which we have been furnished, it was found that no change was produced in the speed or

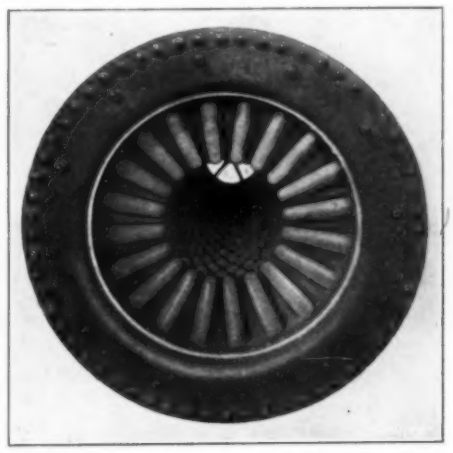


FIG. 38—THIMBLE TUBES OF CLARKSON BOILER

working of the engine by passing the exhaust through the boiler instead of directly to the atmosphere, an observation which indicated that the boiler did not cause back pressure on the engine. In the course of 12½ min., the pressure inside the boiler rose 82 lb. per square inch. The temperature of the gases leaving the boiler was 390 deg. Fah. Measured over a period of 15 min. the evaporation of the boiler was found to be at the rate of 1925 lb. of water per hour, at a steam pressure of 104 lb. per square inch.

In order to maintain the heating services when the exhaust gases are not available, as, for instance, when the vessel is in port, the boiler is fitted with an

auxiliary oil burner, which enables it to take the place of a donkey boiler. On the M.S. Malabar a test conducted with the auxiliary oil burner in use instead of the exhaust gases, showed that a rise in pressure of 78lb. was registered in 30 min., and that the temperature of the gases leaving the boiler was 360 deg. Fah. At a pressure of 103 lb. per square inch the rate of evaporation was 641 lb. per hour. The supply of oil to the burner was restricted, and as a consequence the full power could not be developed. During the test the rate of consumption of the oil was about half a ton per twenty-four hours, a figure which is said to be only about 50 per cent. of the consumption of an ordinary donkey boiler of similar capacity.

British Electric Vehicles, Ltd.

Most of the electric trucks exhibited by British Electric Vehicles, Ltd., of Churchtown Works, Southport, have already been described in our columns, but the midget Whippet elevating platform truck—shown in Fig. 41—is more or less a novelty. It is capable of dealing with loads up to 1000 lb., and is claimed to be the smallest truck of its kind. The vehicle is particularly suitable for use in congested thoroughfares; for it will turn out of a passage way 4ft. wide into another passage of the same width at right angles. It will be gathered from the illustration that the platform is elevated by a hand-operated worm and worm wheel arrangement, to be seen just above the driver's platform. The capacity of the battery, which is slung under the platform, is 93 ampère-hours. Unless the driver is standing on the platform it is impossible for the truck to move. In the event of the driver jumping or falling off the platform the current is cut off automatically, and the brakes are applied, and it is impossible to start the vehicle again unless the driver remounts the platform, when the controller handle must first be returned to the off position. The controller gives three speeds in either direction.

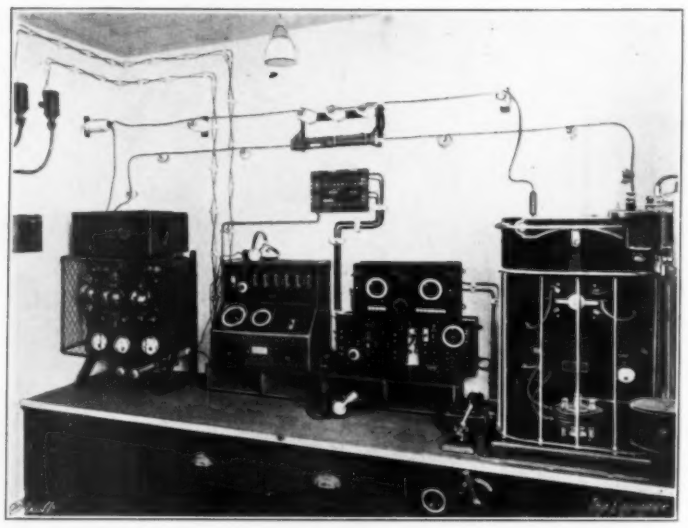


FIG. 39—MARINE TRANSMITTING AND RECEIVING APPARATUS—MARCONI

FIG. 41—ELEVATING PLATFORM TRUCK—BRITISH ELECTRIC VEHICLES

The Marconi International Marine Communication Company.

The Marconi International Marine Communication Company, Ltd., is showing wireless apparatus for a variety of purposes, namely, to provide communication at sea, to increase the safety of life, to assist navigation, and to provide entertainment on board ship. A complete Marconi installation for use on large passenger ships is shown. In addition to a 1½-kilowatt quenched spark transmitting apparatus it comprises emergency apparatus, a marine receiver, and a 1½-kilowatt continuous wave transmitter, which has a long range and is capable of fine tuning—see Fig. 39. The installation also includes a Marconi direction-finder, complete with a small frame aerial, which enables bearings to be obtained with the same high degree of accuracy as that obtained with the large loop aerials formerly used. The new arrangement overcomes the difficulties that were previously encountered in supporting the aerial system with sufficient rigidity, and the direction-finding instruments may be placed in any part of the ship. The frame consists of an open teak structure approximately 8ft. high and 4½ft. square, and the aerials and auxiliary fittings are arranged so that they are accessible for inspection, cleaning and repairs.

It is well known that trials have been carried out by the Government with a view to studying the possibilities of an instrument that would respond to a special signal used as a forerunner of the distress call, the object being to make it unnecessary to maintain a constant watch. Investigations along these lines have been carried out by the firm's engineers for several years, and the company was able to lend the Government apparatus for carrying out the trials. The results of the trials were embodied in a report which has been laid upon the table of the House of Commons, and which includes a specification of the requirements to which such an instrument should conform. The Marconi four-second alarm device exhibited has been designed in accordance with the requirements. It was found that the most suitable form of signal is that which consists of a series of four-second dashes which cause a bell to ring, and this is the principle upon which the instrument is designed.

Interference from spark telephony renders the reception of broadcast concerts at sea difficult, and in response to many requests from yacht owners and owners of passenger ships, the Marconi Company has designed the Marconi V4 broadcast receiver—shown in Fig. 40. The apparatus is provided with special protective circuits to make it suitable for use on board ship, and it can be adjusted for any wave length from 300 to 3000 metres. Under normal conditions it will receive the transmissions of any of the British broadcasting stations at a distance of 250 miles, and the more powerful stations at Daventry and Paris at a distance of 750 miles. Under favourable conditions and during hours of darkness the reception ranges may be increased to 1000 and 2000 miles respectively.

Another exhibit is the Marconi band repeater for ships. The installation comprises a Marconi broadcasting microphone, amplifier and loud speaker, and it enables music played by an orchestra to be reproduced with clarity and good tone in various parts of the ship. Plug and socket connections on decks and in saloons, lounges, &c., may be provided, so that a loud speaker can be put into operation whenever required. For the purpose of demonstration the microphone is installed near the orchestra, and the music is reproduced by means of a loud speaker on the Marconi stand.

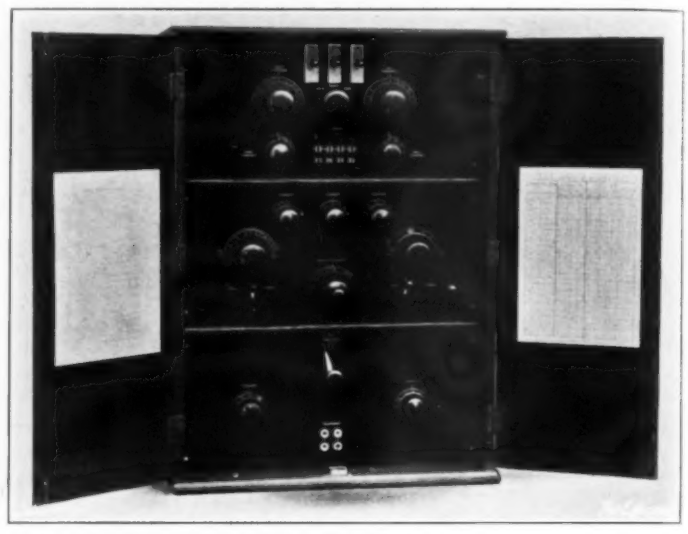


FIG. 40—MARCONI V4 BROADCAST RECEIVER

Electroflo Meters Company, Ltd.

Electroflo Meters Company, Ltd., of Abbey-road, Park Royal, N.W. 10, is showing a collection of its meters for the measurement of the flow of steam, air, gas, water, &c. The principle on which these meters work was described in our issue of May 19th,

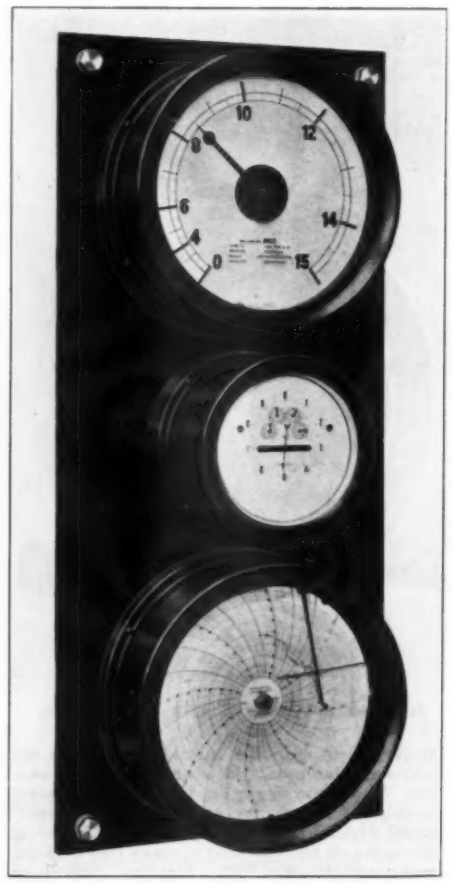


FIG. 42—ELECTROFLO BOILER METER SET

1922. Briefly, a thin Monel metal orifice plate is used in the pipe line for producing a pressure difference which serves to actuate a mercury column in the meter body. The alteration in the level of the mercury column causes the ends of a series of vertical rods of varying lengths to be connected together or disconnected, and thus to add or deduct resistance to a simple electrical circuit. The amount of current flowing through the circuit is therefore directly proportional to the amount of fluid flowing through the pipe line, and the rate of flow and total flow are indicated, recorded and summated on independent

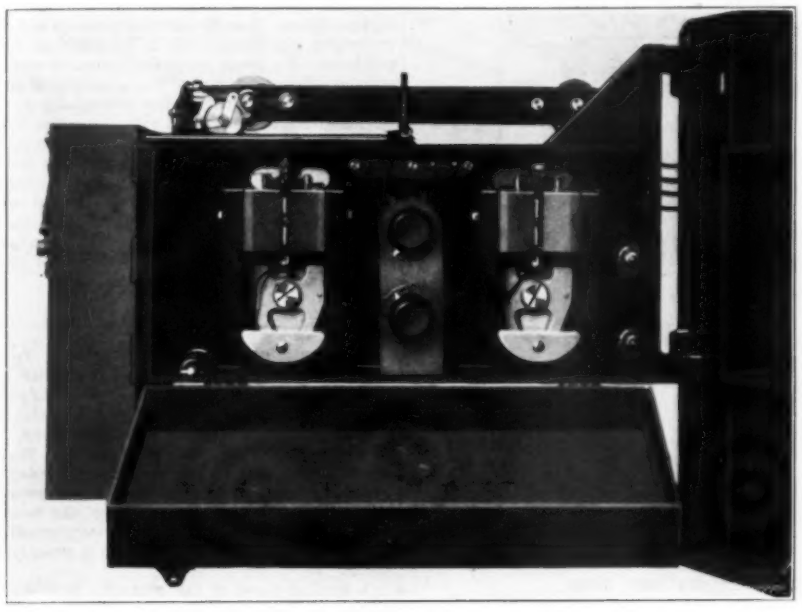


FIG. 43—ELECTROFLO DUPLEX RECORDING PYROMETER

electrical instruments. The instruments may be placed at any desired distance from the point at which the actual measurement is made by means of the mercury column, and if necessary they may be duplicated. This, the makers point out, is of particular advantage in the case of steam plants, for 15in. diameter steam flow indicators may be mounted at the front of the boilers for the guidance of the boiler-house attendants, whilst recorders and integrators may be centralised in a main instrument room, chief engineer's office, or elsewhere. The system is claimed to be equally useful in the case of industrial

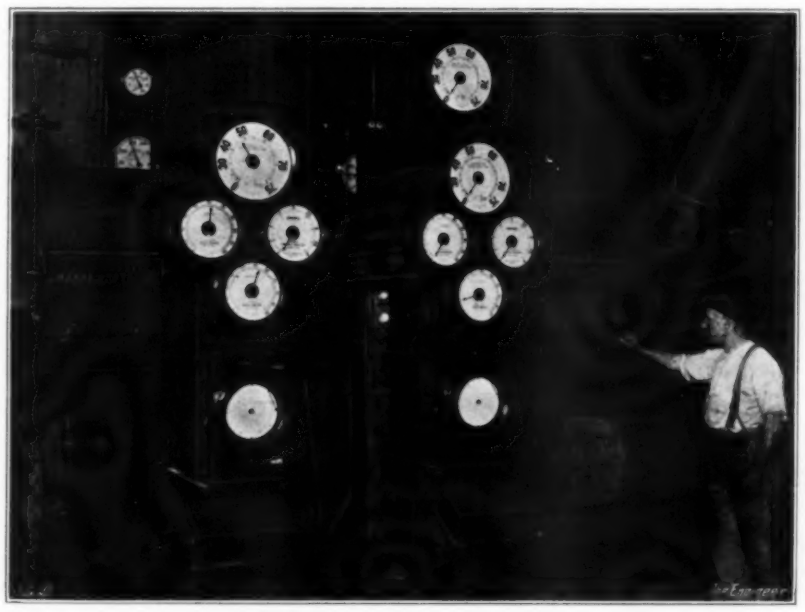


FIG. 44—ELECTROFLO BOILER CONTROL EQUIPMENT AT HARLESDEN

plants, where careful check has to be kept on the steam generated and distributed for process work, heating buildings, &c., as all the reading instruments can be mounted at one point.

For the measurement of steam evaporated by double-outlet boilers the system is also claimed to offer marked advantages. In this case a differential arrangement is inserted in each of the two mains and connections are led to two meter bodies, which are connected electrically in parallel, and the total steam flow is indicated, recorded and integrated on a single set of reading instruments, which may be placed in any desired position. The "Electroflo" boiler meter equipment for single or duplex work consists of a 15in. diameter indicator, a 12in. diameter recorder, and a 5in. dial voltage compensated integrator mounted on a polished slate panel, as shown in Fig. 42, and this complete unit can be mounted in the main instrument room. The 15in. indicator can be supplied for working with air, gas, or water meters. The "Electroflo" meter is also shown as used in connection with the measurement of tank levels, &c., and it will, of course, be understood that, as in the case of the measurement of steam, &c., the indicator may be placed in a position remote from the point at which the measurement is actually made.

"Electroflo" draught and pressure indicators are exhibited as applied to boiler control. Fig. 44 shows an instrument equipment used for the control of Babcock and Wilcox boilers at the Metropolitan Electric Supply Company's Harlesden power station. The equipment consists of 15in. diameter steam and water flow indicators, 12in. draught and pressure indicators, and combined CO_2 indicators and recorders. Various types of CO_2 meters are on view. A 12in. diameter indicating instrument of the caustic potash type has a 9in. scale calibrated for 0/20 per cent. CO_2. This CO_2 indicator is entirely free from glassware and rubber connections. In the construction metal is used throughout and the metal case is provided with a lock and key. One of the company's recent developments is a simple electrical device operating in conjunction with this CO_2 indicator, which gives a continuous record of the CO_2 content on a recorder placed in the central instrument room. Among the company's temperature measuring and automatic control devices is a new "Electroflo" duplex recording pyrometer, which is shown in Fig. 43. A special feature of this instrument is a straight chart, which is claimed to have a greater width than that of any other recording pyrometer at present on the market. The two charts are entirely separate and any two scale ranges may be employed at the same time. A tear-off groove enables the records to be removed with ease and without waste of the chart paper. The complete operating instrument is mounted on a swinging panel which hinges through 180 deg., and every part is therefore made accessible. The electrical system, which is composed of two separate units, is housed on the back of the panel, and a dust and moisture-proof gasket is placed between the mounting bracket and back cover. By means of a 60-ohm resistance, which forms part of the equipment, the requisite changes can be made in the electrical circuit after installation.

Empson Centrifugals, Ltd.

The centrifugal purifying machines shown by Empson Centrifugals, Ltd., 47, Victoria-street, S.W. 1, are intended primarily for cleaning and dehydrating lubricating, transformer and other oils that have

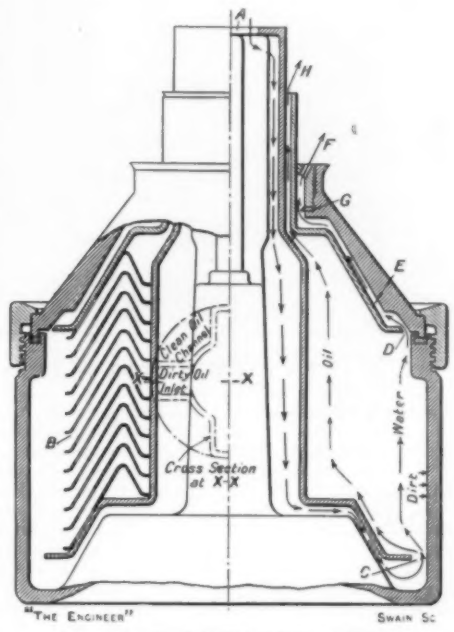


FIG. 45—EMPSON CENTRIFUGAL PURIFIER

become dirty or contaminated in use. If the oils used for such purposes are of good mineral quality, there would appear to be no reason why their efficiency should suffer with continued use, provided the impurities and the water that accumulate in them are removed from time to time.

In the case of a lubricating oil, the simple process

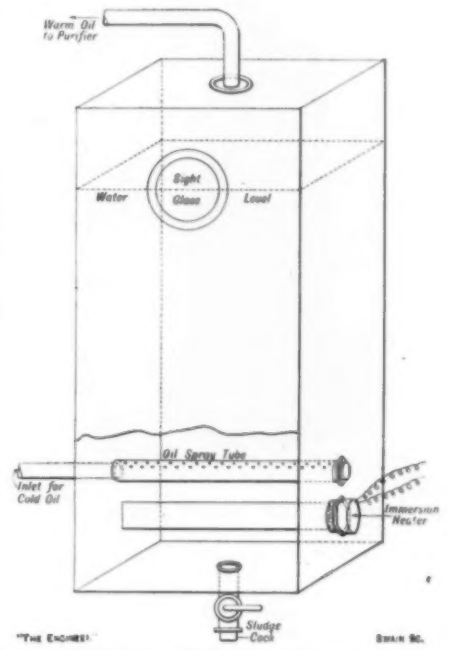


FIG. 46—EMPSON ELECTRICAL HEATER

of standing and decantation does not effect the desired purification in a very thorough and efficient manner. A certain amount of water will nearly always remain behind in the oil, and a certain amount of oil will nearly always be decanted off with the water. Moreover, even after a prolonged period of quiescence fine solids will remain in suspension, and in order to

achieve their removal the oil, after decantation, has to be passed through some form of filter.

The purification of a transformer or other oil which is required to possess a high degree of electrical insulation is still more difficult to effect by ordinary means. It has been shown by Dr. Hirobe, of Tokio, that the dielectric strength of an oil is very greatly affected by the presence or absence of minute microscopic fibres that will not yield to removal by precipitation. It would appear that if the fibres are dry their presence does not materially influence the dielectric strength. A very small amount of moisture

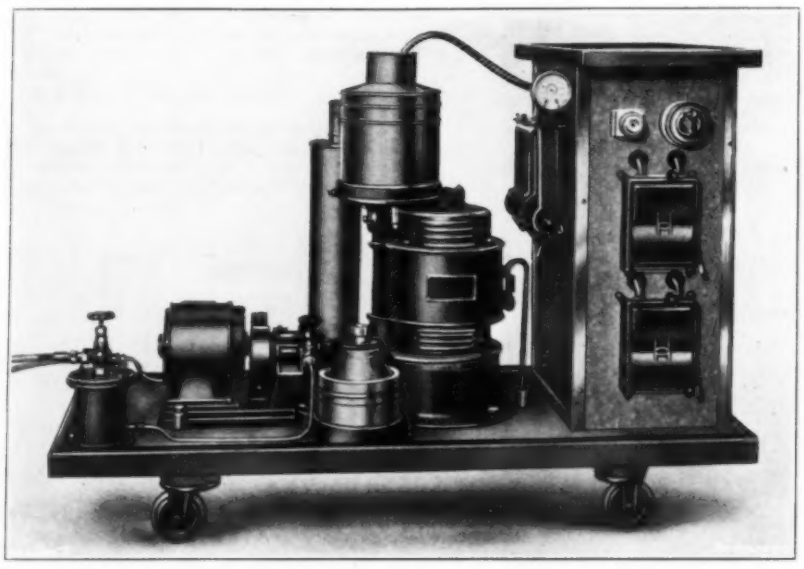


FIG. 47—PORTABLE TYPE OF EMPSON PURIFIER WITH HEATER AND PUMP

added to the oil is, however, quickly absorbed by the fibres, with the result that their specific inductive capacity is altered, which fact causes them ultimately to build up a conducting chain and break down the insulating property of the oil. According to Dr. Hirobe, a pure clean dry oil showing a breakdown voltage of 90,000 volts will, when 0·004 per cent. of water is added to it, fail at 70,000 volts. If the same oil contains microscopic fibres, a like addition of water will cause it to break down at 20,000 volts. It is clear therefore that the filtering of an oil through paper or other cellulose material may lower the

FIG. 48—FIXED EMPSON PURIFIER

dielectric strength by adding fibrous impurities to it. If the oil and paper are quite dry, the lowering of the dielectric strength will not be at once noticeable, but will become apparent as soon as the oil absorbs a slight amount of moisture.

It is claimed for the centrifugal process of purifying oils that it overcomes all the disadvantages of the ordinary processes in use. The Empson type of centrifugal purifier is illustrated in cross section in Fig. 45. This design is applicable both to lubricating and transformer oils. At the outset of a run, water, in many instances heated, is charged into the apparatus through the orifice A. Centrifugal force is communicated to the contents of the apparatus by the rapidly rotating tier of doubly coned plates B. These plates have for the sake of clearness been omitted from the right-hand half of the diagram. Under the action of the centrifugal force, the water piles up against the cylindrical wall of the casing and seals the annular passages at C and D. Rising up the conical passage E any surplus water escapes through holes F in a gland ring at the top of the casing. The depth of the water seal at C D can be varied to suit oils of different specific gravities by changing the sharp-edged ring G for another of greater or less clearance. With the apparatus so charged, the oil to be purified is poured through the orifice A, and, passing upwards through the water seal at C, is there washed at the point of maximum centrifugal effect. Because of its lesser specific gravity, the oil is unable to escape past the seal at D. Instead, it rises up and flows away through the orifice H. On its passage upwards the oil is freed by the centrifugal action from the water and impurities which it contains. Such water and dirt are thrown outwards into the layer of water originally charged into the apparatus, and as this water is added to by the water extracted from the oil, an overflow occurs from the orifice F. A tinware receiver with a spout surrounds the orifice F to catch and discharge the water. A similar receiver catches the oil from the orifice H. A third one surrounds the orifice A and comes into use when sufficient dirt accumulates in the drum to choke the entrance passage. The cleaning of the apparatus can be carried out quickly, for the coned plates, of die-stamped sheet aluminium, can be assembled on the central tube in any order without affecting the balance of the machine.

It is frequently advantageous to heat the sealing water and, in addition, to heat the oil before admitting it to the apparatus. For such purpose the makers supply an electrical heater of a patented type, which, it is claimed, cannot lead to the burning or overheating of the oil. This heater—as indicated in Fig. 46—contains a body of water heated by electrical elements immersed in it. The oil is sprayed into the water at the foot of the tank, and finds its way upwards by gravity to the space above the water, and so to the discharge orifice. During this heating process the heavier particles of sludge in the oil are thrown out, and can be drawn off at intervals through a drain at the foot of the tank. This heater is also employed to heat the sealing water at the outset of a run. In Fig. 47 we illustrate a portable type of Empson purifier, designed for an output of 50 gallons of oil per hour, and provided with an electric heater and a circulating pump. This equipment, it is claimed, is particularly suitable for use at transformer substations. Fig. 48 represents a purifier, also of 50 gallons capacity, designed to occupy as little floor space as possible. This form is operated by an electric motor built into the frame of the machine and driving the drum through a single train of gearing. An automatic clutch is embodied in the drive, which permits the drum to be started gradually and without shock. The speed of the drum is of the order of 7500 revolutions per minute, and about 1 horse-power is absorbed in the drive. Larger sizes of purifier are exhibited, including machines with a capacity of 250 gallons per hour. For some purposes the water-sealing charge may be dispensed with. For example, if the oil contains dirt and impurities, but practically no water, the purifier may be converted into a clarifier by inserting a close-fitting ring at G, Fig. 45. In this case no escape is provided at F. The clarified oil flows out at H and the dirt and impurities thrown out by centrifugal force are retained within the casing. When so run the apparatus has a greater capacity than when used with a water seal. In general, the use of a water seal is recommended by the makers because of the positive washing action which it provides.

SUPER-CENTRIFUGAL ENGINEERS, LTD.

The centrifugal purifying machine, the Sharples Super-Centrifuge, as it is called, exhibited by Super-Centrifugal Engineers, Ltd., of Aldwych House, W.C. 2, is of a type quite distinct from the appliances for the same purpose shown by other firms. The chief characteristic of this design is the fact that no discs or plates, conical or otherwise, are employed, a fact which, it is claimed, simplifies and shortens the cleaning of the apparatus. In addition, the bowl in which the separation takes place is of very small diameter, and can therefore be rotated at a greatly enhanced speed.

A typical form of the Sharples centrifuge is illustrated in Fig. 50. The bowl A is a steel cylinder, 4¼in. in diameter, 30in. in length, and weighing about 35 lb. It is housed within a conical cast iron casing, and is driven by an electric motor or otherwise at 17,000 revolutions per minute. The bowl is suspended from a ball bearing by means of a flexible spindle, and at the foot is guided in a bushing designed simply to limit any lateral movement that may develop. Inside the bowl attached to its upper end is a three-winged vane B, the purpose of which is to prevent the liquid being dealt with from slipping relatively to the bowl, and so losing some of the centrifugal effect. The liquid to be treated is admitted by the pipe C to a jet at the centre of the guide bush at the foot of the bowl. At D a band brake is provided for bringing the bowl to rest after a run.

The action of the apparatus is represented in Fig. 51. The jet of liquid on entering the bowl strikes a horizontal circular baffle plate, which spreads it out sideways. Under the influence of centrifugal force, the liquid piles up round the cylindrical surface of the bowl leaving an air space in the interior. If the liquid consists of a lighter and a heavier component, such as a mixture of oil and water, it will stratify, the lighter constituent keeping to the interior and the heavier going outwards. A ring at the top of the bowl—the ring from which the three-winged vane is suspended—permits the two strata to be separated, the lighter liquid going through the centre of the ring and the heavier passing round its periphery. The two streams find their exits through separate passages in the head and flow into collecting chambers provided with spouts. A third stratum, containing the solid impurities, forms, as indicated, at the foot of the bowl, and there collects until removed at the end of the run. The heavy liquid just

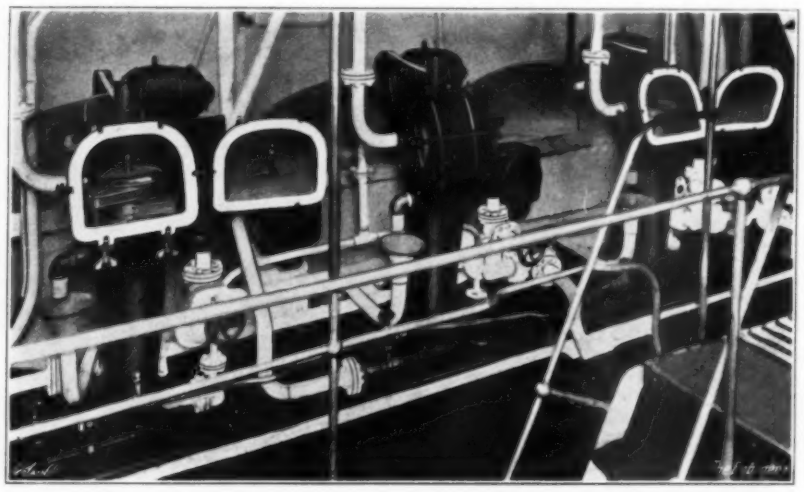
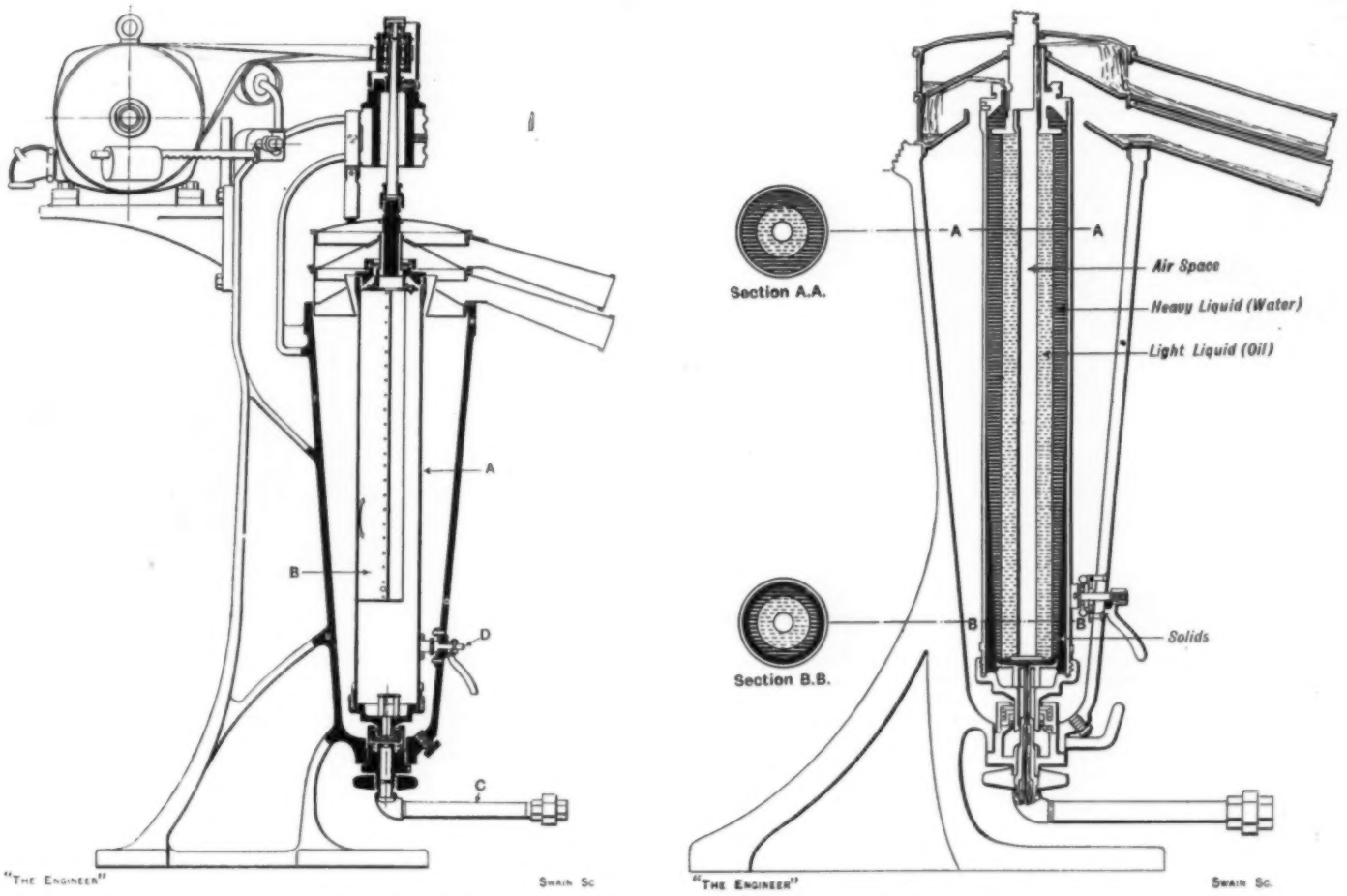
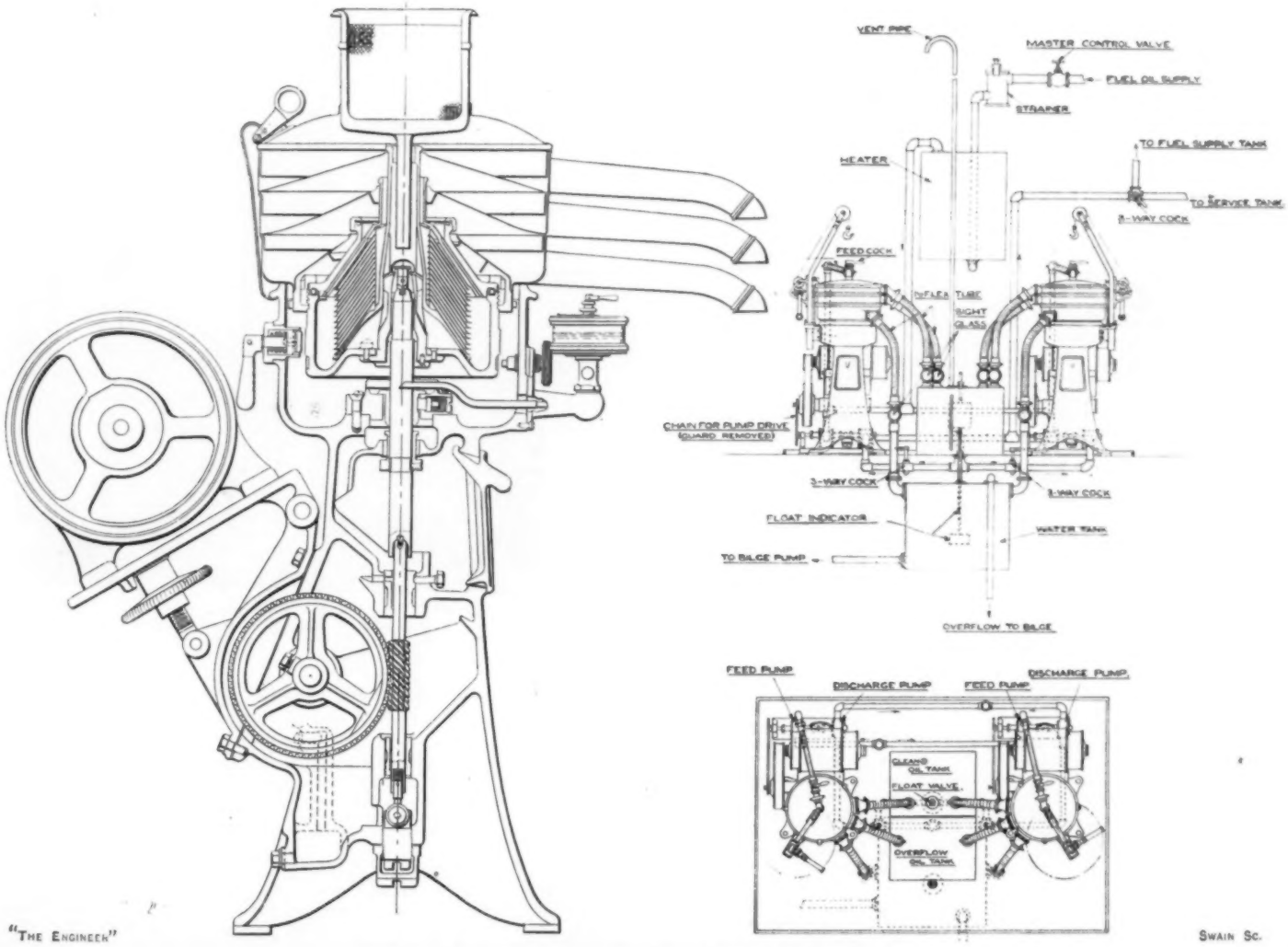


FIG. 49—SHARPLES CENTRIFUGES ON THE M.S. PORT DUNEDIN

CENTRIFUGAL PURIFYING MACHINES AT OLYMPIA



FIGS. 50 AND 51—THE SHARPLES SUPER-CENTRIFUGE—SUPER-CENTRIFUGAL ENGINEERS, LTD.



FIGS. 52 AND 53—THE VICKERS SEPARATOR—BRITISH SEPARATORS, LTD.

before it leaves the top of the bowl has to pass a dam ring, the clearance here provided being variable to suit differences in the relative specific gravities of the two liquid constituents. If zero clearance is provided at this point, the apparatus acts as a clarifier for liquids comprising a single constituent and solid impurities.

Several constructional features of the apparatus are of interest. The motor of about 2½ horse-power and running at 3450 revolutions, drives the pulley at the top of the flexible spindle through a form of woven cotton belt, which is kept taut by a jockey pulley and weight. In some applications the motor is dispensed with, and the bowl driven by a small steam turbine, mounted with its wheel horizontal at the top end of the flexible spindle. The collecting covers are held stationary on top of the conical casing by means of a hinged member with a felt pad at its foot. The band brake is thrown into action by the movement of a lever on the outside of the casing, but the pressure applied by it is controlled, not by this lever, but by a spring which the lever releases. The guide bush at the foot of the bowl is lubricated by the fluid being operated upon if that fluid happens to have lubricating properties. If such is not the case, the design is modified to exclude the fluid from the bush and to admit lubricant through a separate channel.

The industrial applications of the Sharples centrifuge are very numerous. It is made to suit capacities of from 30 to 500 gallons per hour. The ease with which it can be cleaned, combined with the fact that the force which it exerts by the centrifugal action reaches the high figure of approximately 17,000 times the corresponding force due to gravity, permits the apparatus to be applied not only to the purification of lubricating, transformer and fuel oil, but to such diverse duties as the recovery of vegetable oil from soap stock, the clarification of apple jelly stock, bacterial sedimentation and the regeneration of the solvents used in dry cleaning. As an indication of the purification effected by the apparatus, it may be said that tests on a Diesel fuel oil before and after treatment showed that the specific gravity had been reduced from 0·898 to 0·895, the ash from 0·102 to 0·007 per cent., and the water from 2·6 to less than 0·05 per cent. In Fig. 49 we reproduce a photograph of three Sharples centrifuges installed on board the Commonwealth and Dominion Line's motor vessel Port Dunedin, for the treatment of the lubricating and fuel oils. These machines are electrically driven and differ from the type illustrated in Fig. 50 in the fact that they are housed within a casing which totally encloses the collecting trays, &c., and prevents the escape of fumes into the engine-room, an arrangement which is in accordance with the Board of Trade's recommendations on this subject. We are informed that over 150 motor vessels have now been fitted with the Sharples apparatus.

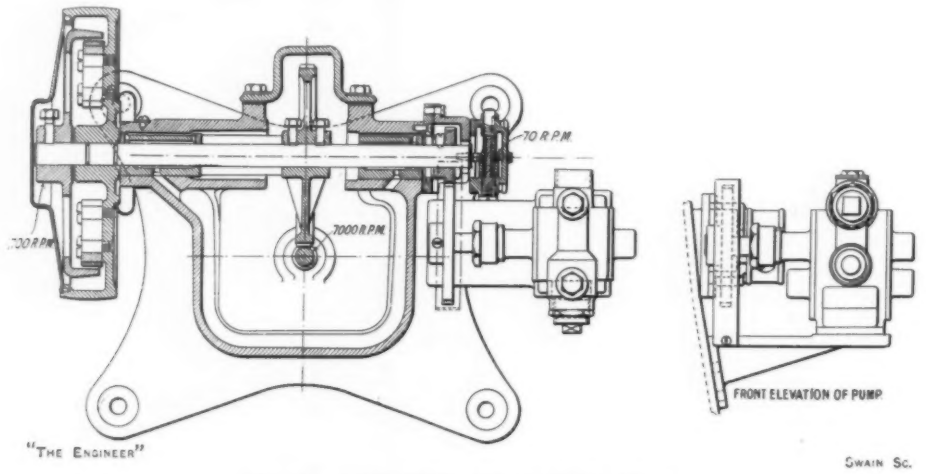


FIG. 54—DRIVING SHAFT OF VICKCEN SEPARATOR

British Separators, Ltd.

Another design of centrifugal separator is shown by British Separators, Ltd., 161, Queen's-road, Peckham, S.E. 15, a firm associated with Vickers Ltd. A typical sectional arrangement of the "Vickcen" separator is given in Fig. 52. The machine, it will be observed, effects the required purification or separation in a rotating bowl within which is disposed a tier of conical plates. The oil or other liquid to be treated reaches the centre of the bowl through an overhead gauze-lined strainer. The water and solid impurities in the oil are shot outwards and are in part retained in the bowl, and in part escape upwards past a discharge ring into the lowest of the three receivers. Provision for this upward passage of the water, &c., is made by forming channels in the upper conical plate, whereby passages are left between this plate and the conical bowl cap. The lighter constituents of the charge—the purified oil—pass through holes in the conical plates and travelling inwards and upwards ascend into the middle receiver. Should the passageways become choked, as they must do in time, the liquid being treated overflows up the pipe of the bowl through which the water, &c., reaches the first receiver.

There are several very interesting constructional details of this machine which deserve mention. Our engraving shows it arranged for a self-contained electric drive. The motor—of 2 horse-power in the largest sizes and of ½ horse-power in the smallest—is mounted on a hinged plate which can be lifted or lowered by means of a hand screw to adjust the tension or fitting of the belt. This belt drives on to a shaft carrying a phosphor bronze worm wheel. As shown in Fig. 54, the belt pulley on this shaft is equipped with a simple centrifugal clutch which permits the bowl to be accelerated to full speed in a few minutes' time, without the employment of an elaborate starter for the motor. At the other end of the shaft a geared drive transmits power to a small pump, which can be employed to draw the liquid to be treated from its tank or to pump the purified liquid to a receiver. At this end of the shaft there is also fitted a speed counter, consisting of a worm-driven plunger, which moves up and down once for every hundred revolutions of the bowl.

The worm wheel drives on to a steel worm and spindle, mounted in plain top and bottom bushes and supported on a footstep bearing of special design, consisting of a spring-loaded chrome steel plunger bearing against two chrome steel rollers mounted side by side on a spindle supported in a screwed plug. This footstep bearing and the lower plain bush run in an oil bath, into which the worm wheel dips. The oil carried round by the wheel lubricates the worm and splashes off on to the upper plain bush.

The worm wheel shaft runs at 700 revolutions and the worm shaft at 7000. At such a speed the bowl has to be permitted free play to find its true centre of rotation. To this end, the bowl spindle is engaged with the worm spindle through a flexible connection. Above this connection the spindle is supported in a bush formed in three parts that yield separately as required under the control of springs. This bush is lubricated from a sight-feed lubricator, and the oil falling from it finds its way through the upper plain bush of the worm spindle into the oil sump below. A spring-loaded brake, faced with Ferodo, is provided for bringing the bowl quickly to rest. On the opposite side of the body a screw is fitted, whereby the bowl can be locked when required. The tier of three receivers is held in the assembled position by means of spring clips that can be moved circumferentially into any position.

In machines of this description much depends upon the facility with which they can be cleaned. To improve matters in this respect, the Vickcen separator can be equipped with the form of lifting apparatus shown in Fig. 55, whereby the bowl and its various parts can be readily lifted and handled. Incidentally, this engraving illustrates a machine of 2000 gallons per hour capacity, equivalent to a throughput of, say 6 tons of Diesel fuel oil. This capacity is claimed to be the highest for any centrifugal oil purifier on the market.

FIG. 55—CLEANING A VICKCEN SEPARATOR

In common with other makers, British Separators, Ltd., has paid close attention to the question of fumeless operation on board ships. To treat the heavier grades of Diesel fuel oil effectively in a centrifugal separator it is desirable to reduce the viscosity by raising the temperature to about 150 deg. Fah. The arrangements adopted by the firm to meet the Board of Trade requirements in this respect are typified in the arrangement illustrated in Fig. 53. The fuel oil, after passing through a strainer, is admitted to a heater, where its temperature is raised to the desired point, either electrically or by means of steam, according to the facilities available. If electrical heating is employed, the adoption of a thermostatic control is advisable, in order to avoid the oil being overheated should the flow fall off for any reason. Each of the purifiers has two pumps, which are driven by chain from the purifier driving shaft. One of these pumps, the feed pump, delivers the oil from the heater into the purifier through a feed valve. By the employ-

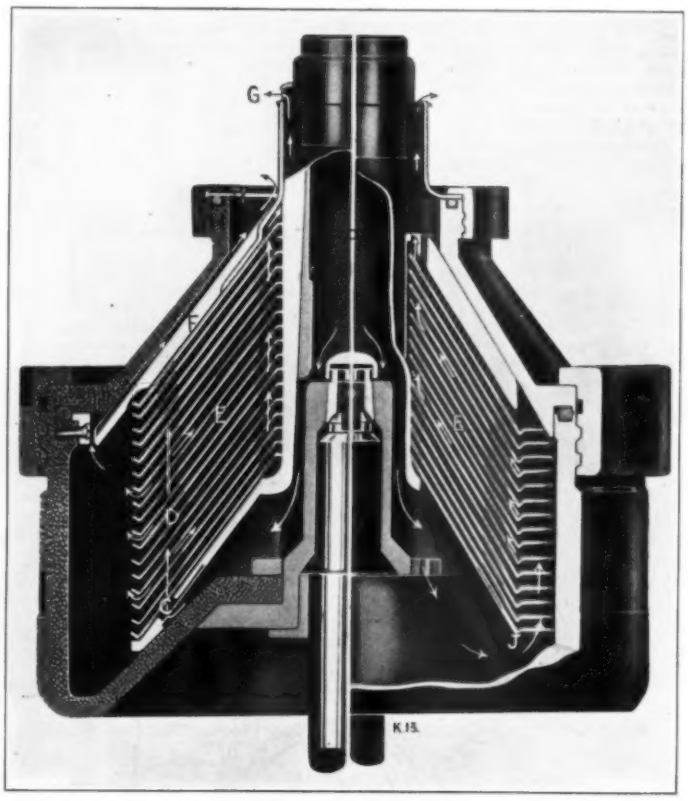


FIG. 56—DE LAVAL PURIFIER BOWL—CHADBURN

ment of this pump the rate of feed is kept constant, no matter what the head of the oil supplied to the heater may be, and, in addition, the feed is automatically shut off when the purifier is not running. The clean oil passes through a flexible pipe into a clean oil tank provided with a float valve which keeps the oil level in this tank constant. The second chain-driven pump, the discharge pump, delivers the clean oil to the service tank, from which the engine draws its supply. The water and dirt separated from the oil are discharged through a flexible pipe into a tank connected with the bilge pump, and a similar pipe and tank are provided for the receipton of the oil which overflows from the separator when it requires cleaning. The three receivers for the water, oil and overflow are made of cast aluminium alloy, with machine-jointed faces. Sight glasses are fitted in each of the flexible pipes leading from the receivers. To facilitate the dismantling of the purifiers, the lifting arrangement illustrated in Fig. 55 is fitted to each purifier, and all the flexible pipes are provided with easily operated wing unions. Each purifier has a capacity of about a ton of fuel oil per hour.

Chadburn's (Ship) Telegraph Company, Ltd.

In many respects the Vickcen centrifugal purifier resembles the De Laval machine, exhibited by Chadburn's (Ship) Telegraph Company, Ltd., of Bootle, Lancs. In fact, having described either, we can find little fresh to say about the other. Messrs. Chadburn have been granted the sole rights and licence for the manufacture in this country of the De Laval centrifugal oil purifier for marine use, and to that end have formed the De Laval Chadburn Company, Ltd. In Fig. 56 we give a diagrammatic section of the De Laval bowl. The liquid to be treated, flowing down the central passage A, reaches the conical annulus B, and flowing through holes C in the conical skirt of the central fitting reaches the plates E. Rising through the holes D in these plates, it is divided into thin streams, and is separated into a lighter and a heavier section. The lighter portion travels inwards and upwards, and overflows at G, The heavier portion goes outwards and, after depositing some of its dirt in the casing of the bowl, flows along channels formed in the top fitting F and escapes past the mouth of the bowl neck H. If the liquid to be purified contains little water, the bowl is set up as shown on the right-hand side of the engraving. It will be observed that the central fitting used for this clarification process has no conical skirt, and that the liquid reaches the plates mainly by a flow round the edges, as indicated at J. The top fitting is also of a modified form, no passages being provided in it for the escape of the heavier portion. The bowl neck, too, is fitted with a funnel which provides but one outlet. It will therefore be understood that, with this arrangement, the solids and other impurities are entirely retained within the bowl until they are cleared out at the end of a run, and that only the clarified liquid is allowed to escape freely. The speed of the De Laval bowl is about 6000 revolutions per minute. The De Laval machine is made in various sizes ranging from a capacity of from 20 to 1400 gallons per hour, and in various stationary, portable and fumeless forms.

Sheepbridge Stokes Centrifugal Castings Company, Ltd.

Having studied the application of centrifugal force to the purification or separation of liquids, the visitor may with advantage direct his attention to the stand of the Sheepbridge Stokes Centrifugal Castings Company, Ltd., of Chesterfield, where he will find particulars of what may very well be described as a reversed application of the same principle.

The employment of centrifugal force for the purpose of forming cylindrical pipe-like castings in iron, steel or non-ferrous metels, has engaged the thoughts of many people here and abroad. Mr. F. W. Stokes began experimenting on the subject at Mansfield in 1916, from which date continuous research and experiment have led to a rapid development of the process, first in the hands of Stokes Castings, Ltd., of Mansfield, and latterly in those of the Sheepbridge Stokes Company, an undertaking associated with the Sheepbridge Coal and Iron Company, Ltd.

The diagrams given in Fig. 57 illustrate the two methods employed in making centrifugal castings. Generally, the horizontal method is the more convenient, but for some castings the vertical type has advantages, while for others the mould may be inclined. The die may be lined with a non-conducting material, but by the careful regulation of the rate of production, the thickness of the die walls and the analysis of the metal being cast, it is stated to be possible to produce castings of grey, readily machined cast iron without the employment of a lining. With the horizontal type of die a layer of metal is added to the bore of the casting at each revolution of the machine, each layer being fed on to those previously formed, the feed taking place under the action of centrifugal force. In effect, the casting is formed on an imaginary or air core, which cannot be otherwise than truly central in the casting. With the vertical type of die the central hole is not truly cylindrical, but, as indicated in the second diagram, assumes a parabolic form, which is more pronounced the slower the speed at which the die is rotated. There can be no doubt, the company informs us, that the higher the speed of rotation of the die, whether horizontal or vertical, the better will be the casting produced. A high speed eliminates the risk of "cold laps," and increases the centrifugal pressure under which the metal solidifies. The higher the speed the greater, too, will be the efficiency with which the dirt and dross and the gases are separated from the metal. Such foreign material being lighter than the metal,

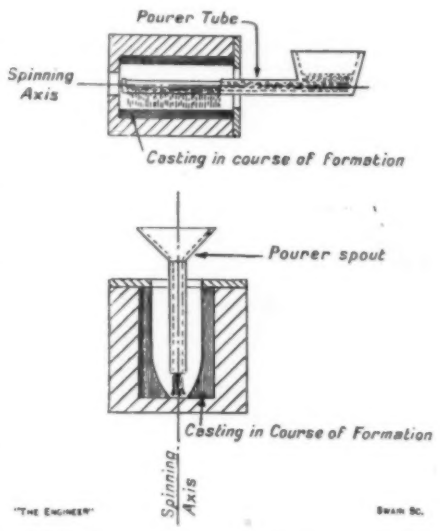


FIG. 57—MANUFACTURE OF CENTRIFUGAL CASTINGS

passes to the inside of the casting, whence it can easily be removed during the casting process. As compared with an ordinary sand casting, it is claimed that a centrifugal casting, by reason of the rapid and uniform cooling action to which it is subjected, has a much finer crystalline structure, with a consequent increase of strength and resistance to wear. The solidification of the metal while in motion tends to distribute the graphite uniformly throughout the mass. The smallness of the graphite plates and the general crystalline character of a centrifugal casting are, it is claimed, such as to render such a casting particularly useful when the temperature conditions are likely to cause trouble by reason of growth or distortion. From the purely practical point of view, attention is drawn to the facts that centrifugal castings prepared in the same mould are very uniform with each other, both in material and dimensions; that they are free from scale, blow-holes and adherent sand; and that they are formed without "gates," or runners, risers or feeder heads.

As regards strength, the company states that daily tests over a period of two years show an average tensile strength of over 19 tons per square inch, with frequent readings as high as 22 tons. The castings are tested by scleroscope before they are dispatched, and are all guaranteed to be capable of being machined at a speed of 30ft. per minute, although speeds very much in excess of this figure can, it is stated, usually be maintained. The machining allowance is as fine as $\frac{1}{16}$in. on the diameter of a 24in. casting. On the company's stand an interesting demonstration is given of the absence of porosity in centrifugal castings. A standard piston ring drum of grey cast iron machined to a wall thickness of $\frac{3}{32}$in. is closed at the ends with water-tight joints. When water is pumped into the interior until a pressure of 1500 lb. is reached, no percolation is visible. A still more searching test, using paraffin under the same pressure, equally fails to reveal signs of porosity.

The company's products are not confined to centrifugally cast piston ring drums. It shows examples of cylinder liners and sleeve valves in cast iron, and other castings in steel, bronze, &c. Some pump liners in monel metal may be especially noted.

The Sheepbridge Coal and Iron Company, Ltd.

On the stand of the Sheepbridge Stokes Centrifugal Castings Company, Ltd., the associated firm, the Sheepbridge Coal and Iron Company, Ltd., exhibits a full-sized working model of the Meredith patented haulage engine, a machine which, by reason of its unorthodox, although not wholly unfamiliar construction, should prove of great interest to most engineers. This engine makes use of either steam or compressed air. The Sheepbridge Company has been developing the Meredith patents since 1923, in which year it built a 10 horse-power engine. On test this engine proved satisfactory, but before placing the machine on the market, it was decided to build six of a similar size and to test them under every-day conditions in various South Yorkshire and Derbyshire collieries. Since December, 1923, some of these engines have been returned to the works for examination, and it has been found, we learn, that the wear of the working parts has been negligible, while the consumption of compressed air per brake horse-power hour was practically the same as when the engines were first made. One of the sets has been working for some time two seven-hour shifts per day, hauling four tubs at a time, representing a gross load of 4½ tons on a gradient of 1 in 24, the air pressure used being between 70 lb. and 80 lb.

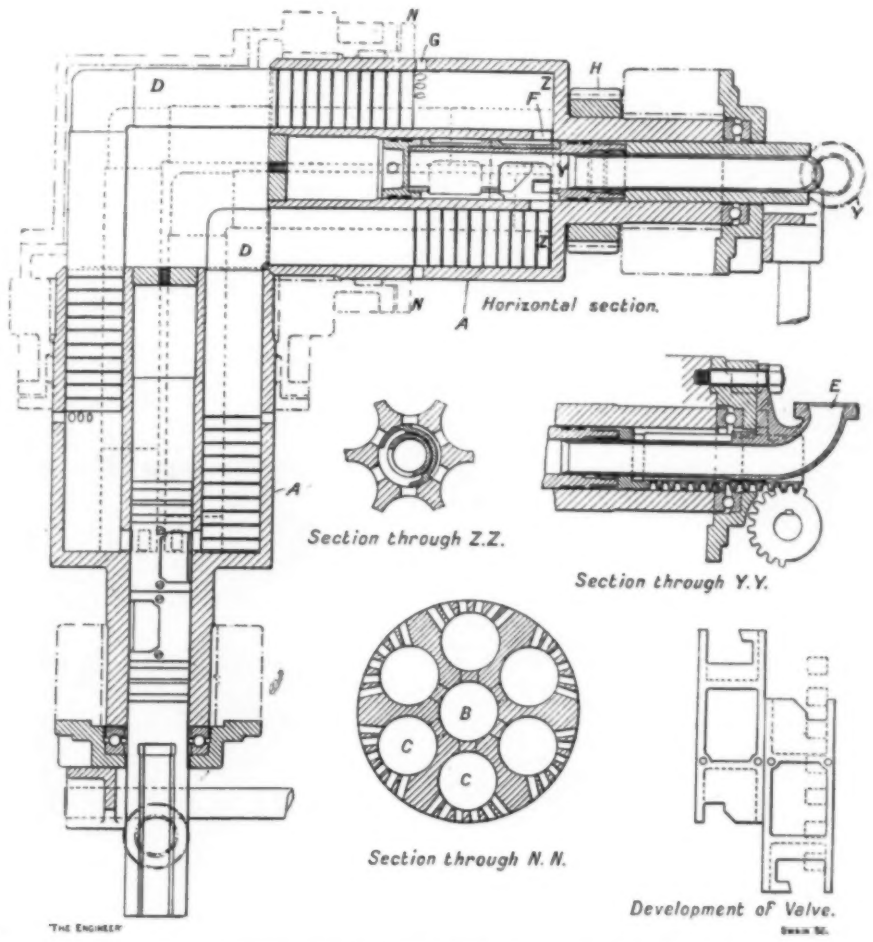


FIG. 58—MEREDITH ENGINE—SHEEPBRIDGE COAL AND IRON CO., LTD.

A sectional arrangement of the Meredith engine is given in Fig. 58. Two cylindrical bodies A A, capable of rotation, but not of endwise movement, are disposed at right angles to each other. Each contains a central passage B surrounded by six cylinder bores

C containing six double-ended pistons D, each bent through 90 deg. The central passages B each contain a valve which is stationary during the operation of the engine, but which can be moved endwise by a rack and pinion arrangement to vary the cut-off or reverse the motion. These valves surround and slide on the pipes E, supplying working fluid to the engine. Inlet ports F admit the fluid from the valve chests to the cylinder bores, and exhaust ports are provided at G. At H one of the rotating bodies is equipped with a pinion from which the power developed is transmitted.

The action of the engine is clear from this description of its parts. It is obvious that if both the bodies A are rotated through 180 deg. at the same speed, but in opposite directions, the pair of pistons D shown in the inner position will move into the position of the outer pair. Conversely, the admission of working fluid behind both the pistons of the inner pair simultaneously will force them into the position of the outer pair, and at the same time communicate rotation to the bodies A. A little reflection will show that continuous rotation of the bodies A can be achieved without the pistons fouling each other, but something more than a little is perhaps required to understand why all the power developed can be obtained from a pinion H on *one* of the bodies A. The compression of the working fluid on the return strokes of the pistons is relieved by the provision of recesses on the valves.

The advantages claimed for the engine are several. The working parts are few in number, those actually taking part in the running being only eight, namely, the two cylinder bodies and the six pistons. The space occupied is very small, and the design readily permits the total enclosure of the engine, a feature of much importance in a coal mine or elsewhere in a dusty atmosphere. There is no "dead centre" in the motion, and the engine can, it is claimed, be started quickly on full load from any position and can be reversed as rapidly as the reversing lever can be moved. The balance, it is stated, is perfect, and the engine is noticeably free from vibration when at work. Lubricating oil is economised by virtue of the fact that the screw-like relative motion between the pistons and cylinder bores is very favourable to efficient lubrication. Finally, the efficiency of the engine is stated to be very high, tests showing a consumption of 21 cubic feet of free air at a pressure of 90 lb. per brake horse-power hour. The engine, we are informed, has been approved by the Inspection of Mines Department. In Fig. 59 we give a view of a completed 12 brake horse-power engine, and in Fig. 60 a view showing a similar size of engine mounted on a truck and provided with a drum for haulage purposes.

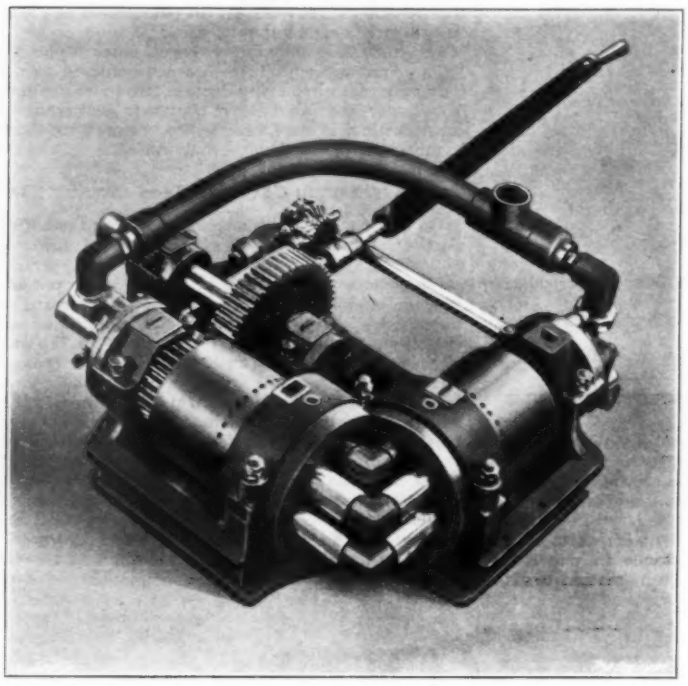


FIG. 59—12 B.H.P. MEREDITH ENGINE

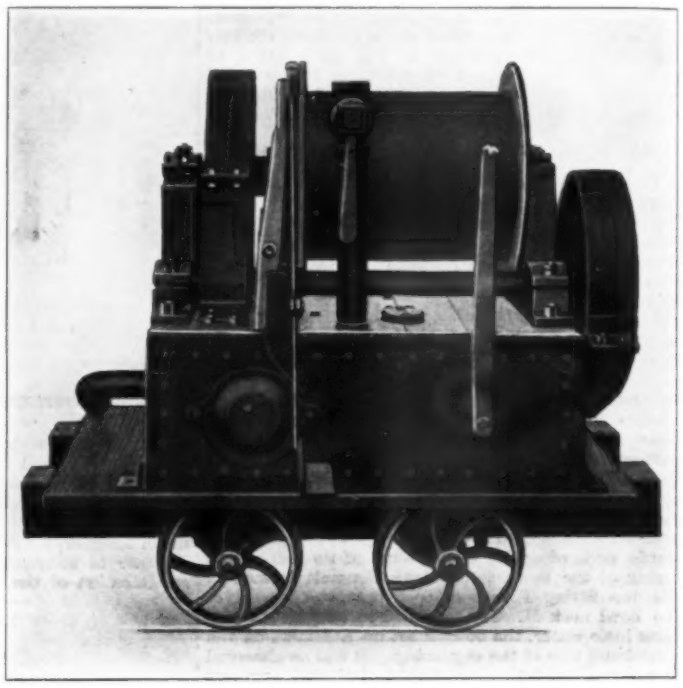


FIG. 60—MEREDITH MINE HAULAGE TRUCK

THE GODFREY ENGINEERING WORKS.

For some years past we have had occasion, as exhibition followed exhibition, to refer to the oxygen jet metal cutting machines made by the Godfrey Engineering Works, of Boundary-road, Wood Green, London, N. 22; but little opportunity has been offered to make an extended notice, as the apparatus has retained its standardised form. This year, however, the firm is showing an entirely new model, illustrated in Fig. 61, besides having extended the application of the original universal form to such work as cutting out a complete locomotive side frame in one operation, while some very successful trials have been carried out for the Admiralty in the way of cutting up armour plate.

The new machine, illustrated in Fig. 61, is what might be described as of the template type—that is to say, the jet is guided round the contour to be cut by means of a template, although simple cuts, such as straight lines or circles, can be made without the use of templates. Another innovation, as compared with the original universal machine, is the optional use of a coal gas blow-pipe in the place of one using acetylene for the heating flame. Coal gas is slightly slower in its action, but the blow-pipes are so designed that they are interchangeable.

Several forms of the new machine are exhibited, and that which we illustrate has a set of round bars to form the main slides, but another type has the slides much in the form of a lathe bed, while the whole machine is arranged to bolt down on a bench, to stand on its own pedestal or to be portable.

On referring to the illustration it will be seen that there are two separate pairs of slide bars. To the upper pair there is clamped an arm which is used to hold the template. The template is built up principally of plywood and can, it is claimed, be very quickly made. The lower pair of bars carries a slide which is mounted on ball-bearing rollers. To this slide there is attached a set of transverse projecting slide rods, and on these rods there is a saddle, again ball bearing, which carries the blow-pipe. The arrangement provides freedom of movement for the blow-pipe in one plane, and while it is so rigid that no backlash can be felt in any part, the least touch will set the saddle in motion, a feature of much importance in the operation of a machine of this class.

Inside the saddle there is a set of worm gearing, combined with a reversing gear and stop motion, which drives a spindle extending vertically upward. The gearing is worked, through a length of flexible shafting, by a little electric motor which drives the friction disc variable speed gear shown on the left of the illustration. By moving the friction wheel across the face of the driving disc the speed of the vertical spindle in the saddle is capable of being regulated to a nicety. On the top of the vertical spindle there is a rubber roller, and this, by bearing against the face of the template, drags the saddle, and consequently the depending blow-pipe, round the contour to be cut.

Although this machine has been brought out, primarily, to serve cases in which the capital cost of the universal machine would not be warranted, it can do work lying within its range, at an equal speed.

A noteworthy fact in connection with oxy-acetylene cutting is the importance of using pure oxygen, and Mr. Godfrey has shown us records which indicate plainly that only small amounts of nitrogen in the oxygen bottles not only reduce the speed of cutting seriously, but also increase the consumption of oxygen. Thus taking oxygen of 99·7 per cent. purity as unity—it is not economical to use a better gas—if the purity is reduced to 98 per cent. the increase in time to make a cut is 19·3 per cent. and the increase in oxygen consumed is 41 per cent. If there

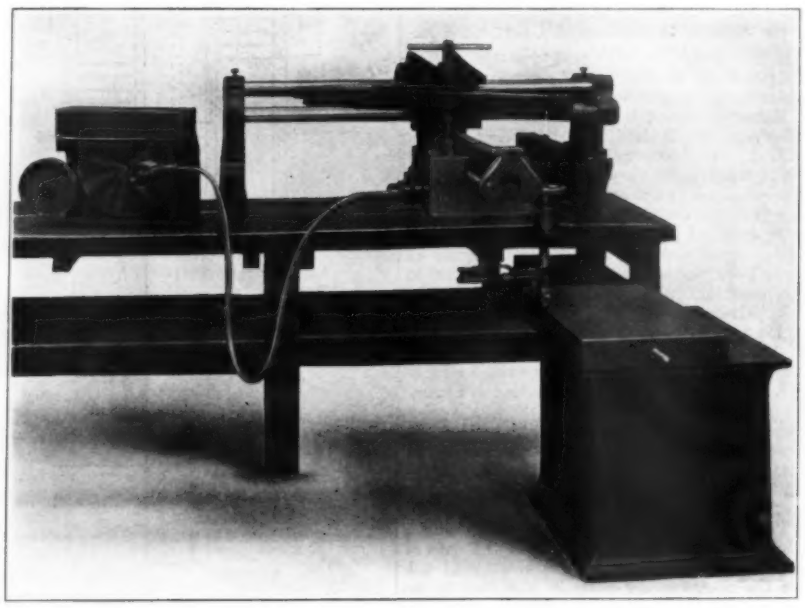
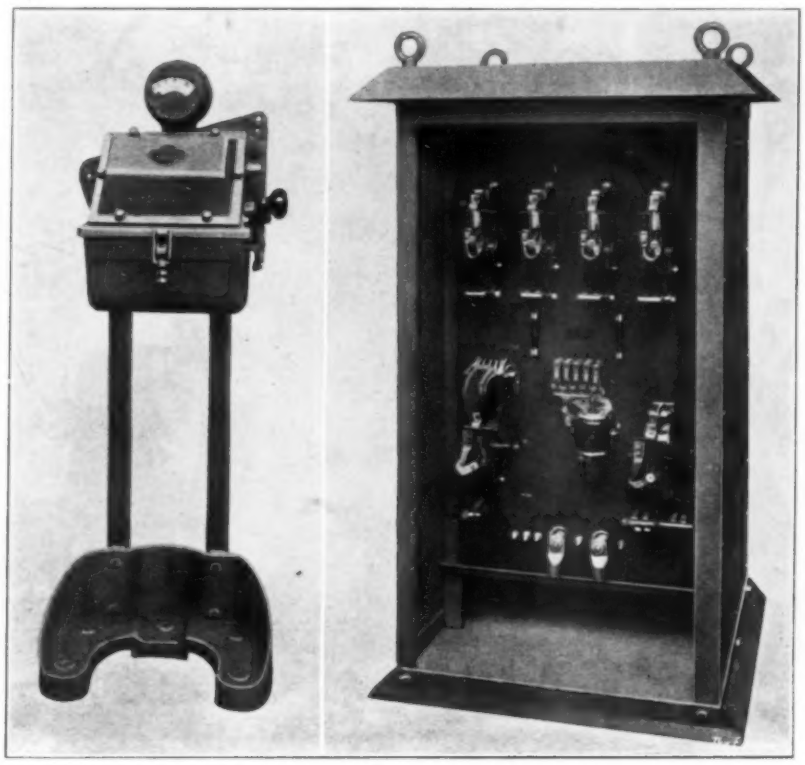


FIG. 61—GODFREY OXYGEN JET METAL CUTTING MACHINE

is only 90 per cent. of oxygen in the gas in the bottle the time of cutting is increased by 130 per cent. and the oxygen consumed goes up by 150 per cent. It is obvious, in these circumstances, that the owners of oxy-acetylene cutting appliances should take steps to ensure that their supplies of oxygen are as pure as possible.

The Igranic Electric Company.

The illustration—Fig. 62—shows one of the Igranic Electric Company's exhibits, which is the company's latest type of star-delta switch, fitted with a patented thermostatic overload relay movement. The switch is of the drum type, and there are revolving arc barriers between each of the fingers. The switch is constructed on the unit principle, one of the chief objects aimed at in the design being to make the parts accessible, so as to facilitate repairs. In the case of large size switches the drum can be removed complete in a few seconds. The switch can be supplied with an air break or the contacts may be immersed in oil, and it can be arranged to act as a star-delta switch, a series-parallel starter, or an auto-transformer starter.



FIGS. 62 AND 63—IGRANIC STAR-DELTA SWITCH AND CONTACTOR PANEL

Another of the company's exhibits is shown in Fig. 63. This is one of the firm's automatic contactor panels, which are used on an extensive scale for starting direct-current motors driving compressors and centrifugal and other pumps. The panels operate under the control of some form of master device, such as a pressure regulator, tappet switch, push button or float switch. A similar range of panels is made for use with alternating-current motors of all types and voltages.

A third exhibit is the automatic starting rheostat—shown in Fig. 64. These rheostats, which are capable of giving speed regulation, are suitable for use in conjunction with motors driving printing machines or machine tools. The panels are claimed to be entirely fool-proof, and after a printing or other machine is ready for work the starting and stopping may be entrusted to the machine minder. The switch is designed to permit of "inching," and as the field circuit is interlocked, the motor always starts with full field, and subsequently it runs up to a predetermined speed.

Besides these exhibits, the company is showing a full range of its standard hand-operated and automatic control panels for alternating and direct-current motors, battery charging panels, theatre dimmers, a lifting magnet and wireless apparatus.

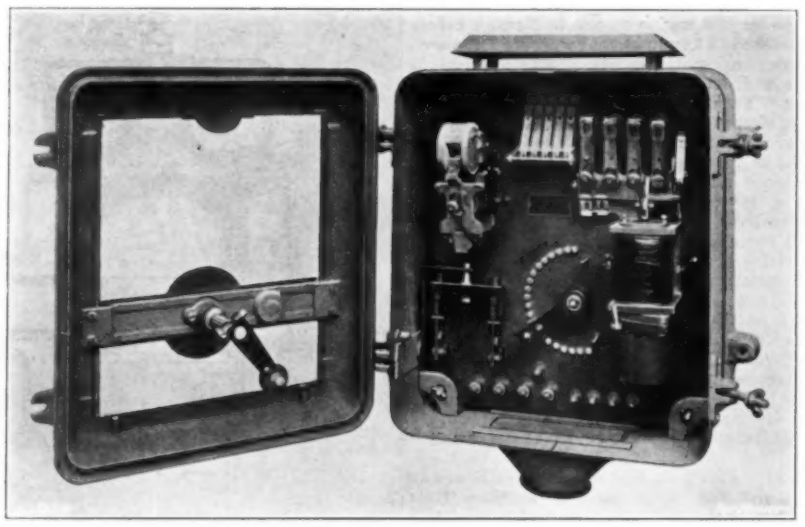


FIG. 64—IGRANIC AUTOMATIC STARTING RHEOSTAT

Automatic and Electric Furnaces, Ltd.

Automatic and Electric Furnaces, Ltd., is showing examples of the Wild-Barfield electro-magnetic furnaces, some of which are in constant operation. During the last few years some new features have been embodied in the design of these furnaces, and the illustration—Fig. 65—shows a furnace fitted with a new type of control board and magnetic indicator mounted in an aluminium case. Briefly, the process of hardening a plain carbon steel consists in heating it until the cementite or iron carbide and ferrite or iron, coalesce and form a solid solution, which is then fixed by quenching the steel in water or oil. If the steel has been heated to exactly the correct degree, it will show subsequently on being fractured a fine grain, which is accompanied by maximum strength, toughness, resistance to wear, and the ability to take and retain a keen cutting edge. The slightest degree of overheating, however, produces a coarse grain, which reduces the strength and durability of the metal, even though the hardness may appear to be unaffected. Very slight underheating, on the other hand, results in the development of soft spots and general irregularity of the structure. The temperature at which steel passes into the state of solid solution is not a fixed quantity, for it depends upon the composition of the steel, its past history, and very largely upon the duration of the heating period.

It follows, therefore, that ideal results can never be consistently obtained when the operator is dependent upon temperature measurements alone. The only way, the makers of these furnaces contend, to determine when the steel has reached the right molecular condition for withdrawal from the furnace is to provide means for showing its magnetic condition, and this is the function of the magnetic indicator to which we have alluded. The operator has simply to keep an eye on the indicator, and as soon as it shows that the steel is beginning to lose magnetism, he watches it carefully until the needle ceases to move, when he quenches the steel.

FIG. 65—WILD-BARFIELD ELECTRIC FURNACE

The electrical circuit for the arrangement is shown in Fig. 66, where F is the primary or heating winding of the furnace, D the secondary winding on the furnace

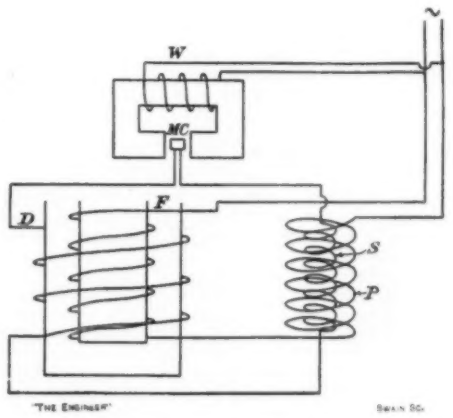


FIG. 66—DIAGRAM OF WILD-BARFIELD FURNACE

casing, S and P the secondary and primary windings of a so-called compensator. M C is the moving coil of the magnetic indicator, and is attached to a pointer moving over a scale. W is a winding on an electro-magnet, between the poles of which the coil M C moves. Normally an electromotive force is induced in the coil D, and is opposed and completely neutralised by an equal electromotive force induced in the coil S. As soon, however, as a piece of steel is introduced into the furnace, the electromotive force in the coil D is augmented by the presence of the steel. The electromotive force opposing it in the coil S is overpowered, and a small current is caused to circulate through the coil M C, thus causing it to move on its axis, when generally the pointer is de-

flected completely across the scale, against a stop, where it vibrates and gives rise to a musical note, so long as the steel is in the magnetic condition. When the steel has nearly attained the non-magnetic condition, however, the pointer leaves the stop and moves down the scale, finally coming to a standstill when the steel has lost its last trace of magnetism, and if the steel is then immediately withdrawn and quenched it is hardened under the best possible conditions. Whether the rate of heating has been fast or slow is a matter stated to be of no consequence.

The firm is also showing for the first time a visual pyroscopic tell-tale, which consists of two relays, one connected across the furnace secondary and the other across the secondary of the compensator. This relay is adjusted so that it switches over from one lamp to another when the electromotive force from the furnace secondary is just a little higher than that of the compensator secondary. When the charge is fully magnetic the electromotive force from the furnace secondary is sufficient to overpower the solenoid connected to the compensator secondary, whilst, when the charge is approaching the non-magnetic condition, the compensator solenoid overpowers the furnace solenoid, and the lamps are thus changed over. This arrangement of lamps leaves the hardener free to attend and work a number of furnaces, tempering mufflers, &c.

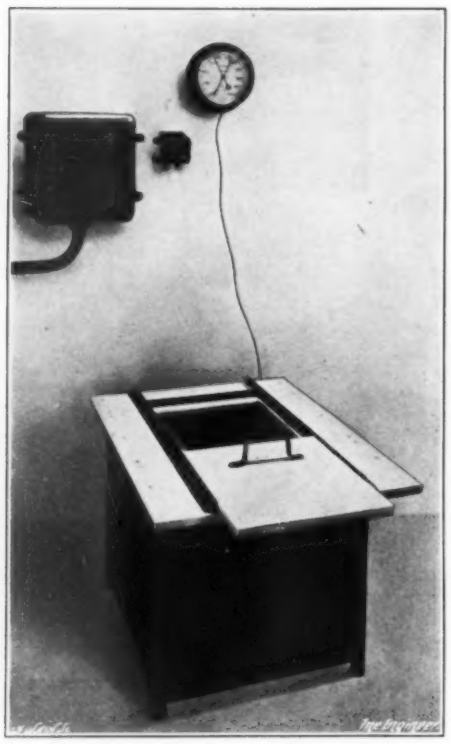


FIG. 67—TEMPERING BATH—AUTOMATIC FURNACES

Another exhibit to which attention should be called is the firm's new type of electrically heated oil tempering bath—as shown in Fig. 67. The heaters are directly immersed in the oil, an arrangement which has been found to give very efficient oil circulation, and the power consumption is small. The upkeep cost, moreover, is said to be negligible.

The Parsons Marine Steam Turbine Company, Ltd.

Since Sir John Biles read his paper before the spring meetings of the Institution of Naval Architects, interest in the high-pressure, high-temperature type of marine steam turbine equipment has undoubtedly been quickened. Even already a vessel of this type for service on the Clyde is under construction by Messrs. Denny at Dumbarton. This development is illustrated on the stand of the Parsons Marine Steam Turbine Company, Ltd., by means of a model of a high efficiency marine geared turbine installation suitable for a single screw vessel of 5000 shaft horse-power. Steam is generated in water-tube boilers at a pressure of at least 500 lb., and is superheated to a temperature of 700 deg. Fah. The turbines are in three pressure stages running at 5000, 3000 and 1700 revolutions per minute. The three units drive separate pinions, and are coupled through double-reduction gearing to the propeller shaft, which runs at 90 revolutions, corresponding to a speed of 14 knots. The model, it is stated, shows the latest type of geared turbines for mercantile marine use, the arrangement being based on recent practice followed in connection with high steam pressure Parsons turbines in land stations. It is claimed that under this system the machinery equipment is lighter than any existing arrangement of geared turbines, reciprocating engines or internal combustion plant of similar power, and is more economical when running costs, interest on capital, depreciation and other factors are taken into due consideration.

The Parsons Company also shows other models, including one of the steam yacht Turbinia, the first vessel to be fitted with Parsons turbines, which was built at Wallsend in 1894.

Worthington-Simpson, Ltd.

The principal exhibit on the stand of Worthington-Simpson, Ltd., of London and Newark-on-Trent, is a new type of Worthington vertical oil engine, which presents several interesting features. It is of the two-stroke cycle solid injection type, and is remarkable for its simplicity of design. The makers claim that in this new design they have met the demand for an oil engine which, while possessing the good qualities of the Diesel type, is much more simple in its construction, but is equally capable of giving continuous and reliable service with the minimum of attention. The particular model exhibited, illustrated in the engraving Fig. 68 and the sectional drawing Fig. 70—see page xix.—is a three-cylinder engine. It is designed to develop 225 brake horse-power total when running at the moderate speed of 275 revolutions per minute. Each cylinder has a diameter of 15¼in., with a stroke of 16in. We were recently privileged to see this engine on test at Newark before it was dispatched to Olympia, and we were impressed by its silent running, the excellent way in which it took up its load, and the general ease and quickness of starting. Various sizes of engines were going through the shops at Newark-on-Trent, and upwards of eight have already been built, although work was only started on this type of engine a few months ago. It is of interest to learn, however, that upwards of 250 engines, representing 30,000 to 40,000 brake horse-power, have already been built to this same design, and successfully applied in America for both land and marine work.

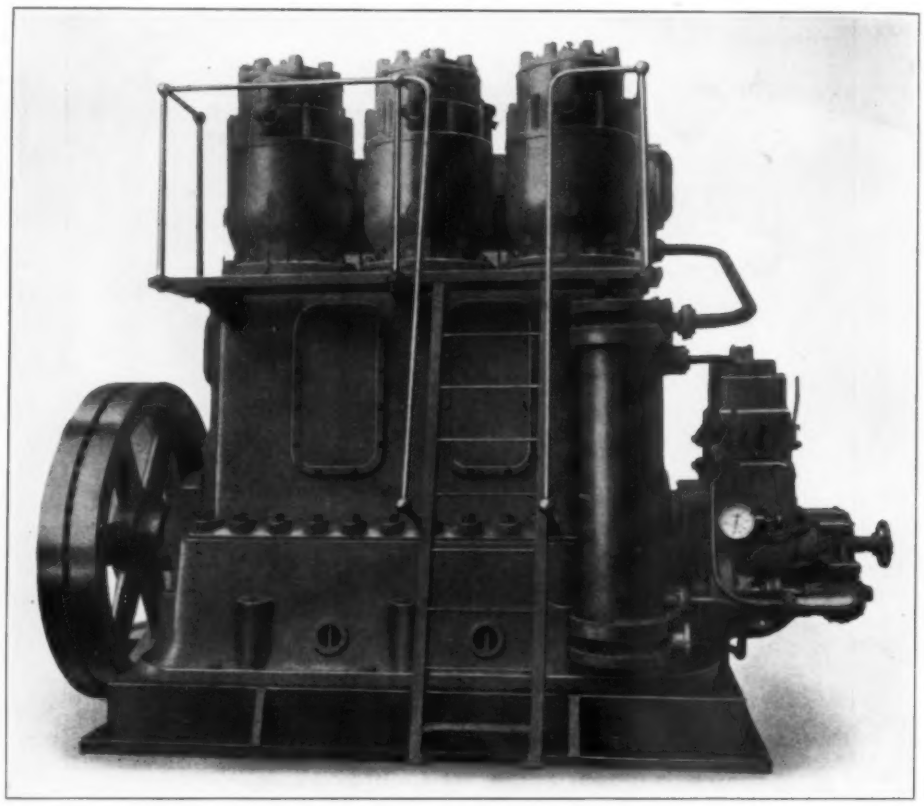


FIG. 68—225 B.H.P. HEAVY OIL ENGINE—WORTHINGTON-SIMPSON

The fuel spray valve and the fuel injection arrangements which are designed to give controlled combustion are of particular interest. Drawing, Fig. 69, is a section through the cylinder, showing the piston at the top of its stroke. It will be noted that there is a divided injection chamber, consisting of an upper cylindrical portion A and a lower dome-shaped portion D, divided by the plate C, which is provided with an ejection orifice. The top face of the piston F is machined flat, so that when on the top centre it practically coincides with the bottom face E of the cylinder cover. The spray valve or atomiser B is fixed in the top of the cylinder cover, and is furnished with a fuel test cock. The spray valve itself is automatic in action, and when the non-return check valve is opened by the oil fuel pressure, the oil is sprayed through fine holes in the atomiser cap. The principle of operation is briefly as follows:—During the up stroke of the piston pure air is compressed into the dome-shaped space above the piston, and into the upper injection chamber. At the end of the stroke the pressure in the space between the piston and the cylinder cover is raised to probably 475 lb. per square inch, with a pressure of, say, 450 lb. in the injection chamber. About 16 deg. before top dead centre the fuel pump delivers oil to the spraying valve and fuel injection begins. As the first particles of fuel reach the heated air in the upper injection chamber, a very small amount of fuel becomes ignited and burns, thus raising the pressure in the chamber to something above that in the space immediately above the piston. The exact amount of this pre-combustion, as it may be termed, is controlled by the particular design of injection chamber and ejection orifice, and these parts are so dimensioned that the main charge of oil spray, together with the products of pre-combustion are confined in the lower part of the upper injection chamber. Just about dead centre, when the end of the period of injection which coincides with the end of the pre-combustion process is reached, the change of pressure reverses the direction of flow through the ejection orifice, and instead of there being upward flow of heated and compressed air, a downward flow of gasified fuel takes place. The flow is accelerated by the downward moving piston, so that the combustion is progressive as the stroke of the piston proceeds. It will be appreciated that the pressure conditions on either side of the

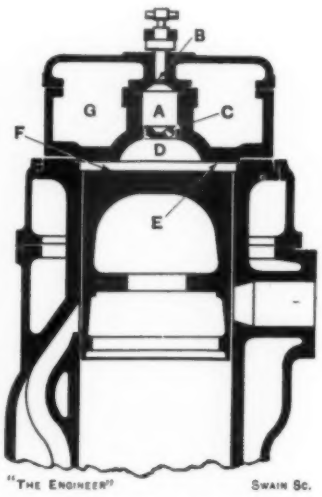


FIG. 69—SECTION OF CYLINDER

ejection orifice regulate the burning of the fuel, and that combustion is non-explosive in character. The absence of any shock is further ensured by use of the underside of the piston as a scavenge air cylinder, an air receiver being formed by the space above the crosshead guides and the frame around the base of the cylinders. By this means the scavenging air is uncontaminated by crank case oil. Any water or vapour collecting in the air spaces may be drained off by cocks arranged on the crank case at the back of the engine. Air enters special passages cast into the

bed-plate and columns, and is drawn into the receiver space through light valves formed of straight strips of spring steel. The volume of the air spaces is so proportioned relatively to piston displacement that a scavenge pressure up to 3 lb. per square inch can easily be maintained. The Worthington design of engine is practically standard as regards main scantlings, and all running parts are enclosed in light casings, with large doors and water connections. Lubrication of the main running parts is effected on a continuous pressure system, and the cylinders are served by a special mechanically operated lubricator. The fuel pump and governor controls are neatly arranged at the end of the engine and a fully automatic air starter is incorporated in the design. At this end of the engine a gear-driven water-circulating pump, a lubricating oil cooler and an interchangeable duplex filter are also fitted. Numerous tests which have been made show that a fuel consumption of under 0·44 lb. of oil fuel per brake horse-power hour can be maintained with even the smaller sizes of engine, with great economy in lubricating oil consumption. The above-quoted figure may be correspondingly reduced, we learn, with larger sizes of units. In addition to the type of engine we have described and illustrated which may be employed for pumping, power and lighting and other industrial purposes, a marine type of engine, with self-contained pumps and reversing gear, is built.

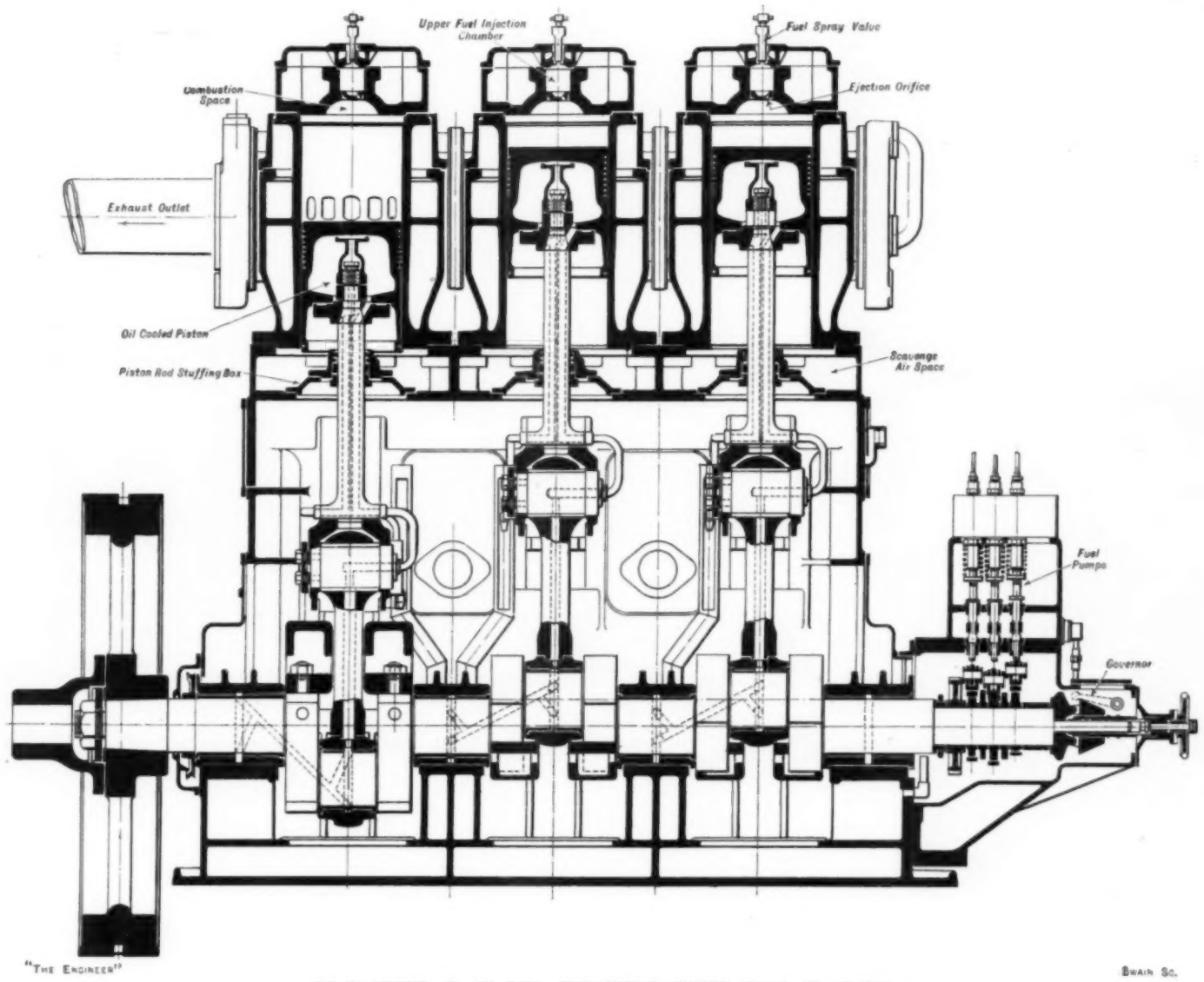
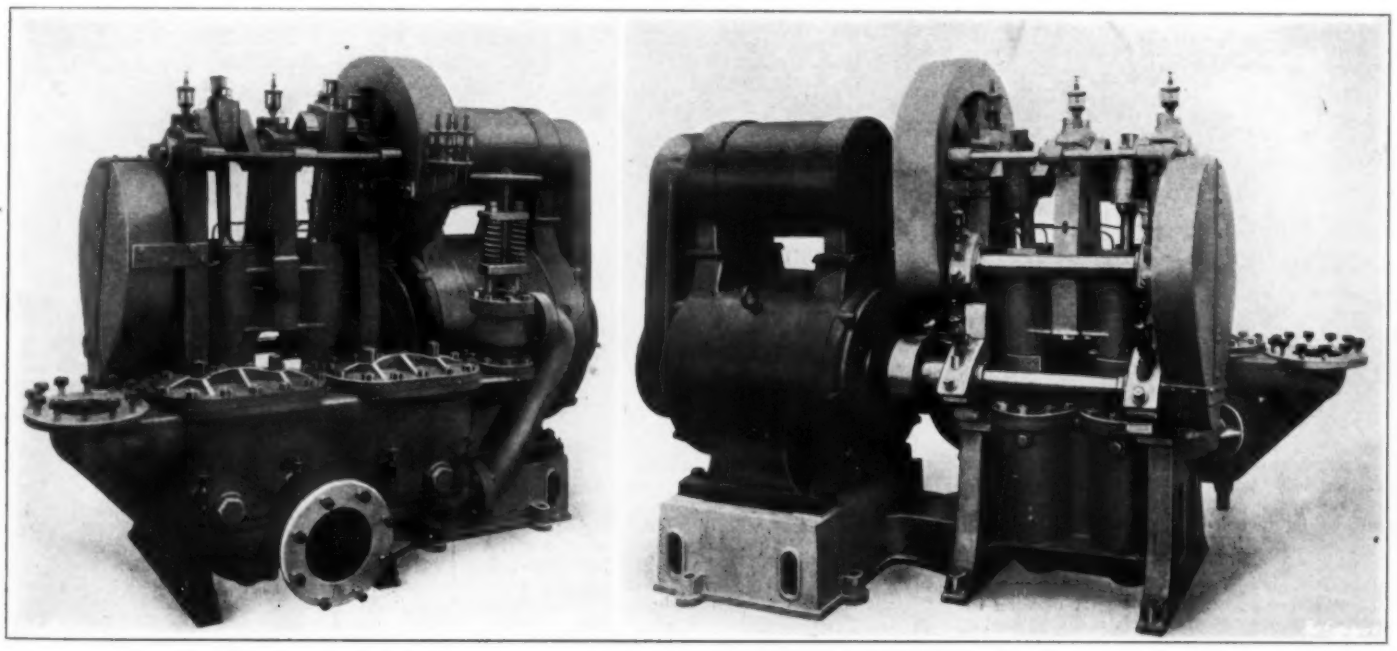


FIG. 70—SECTION OF 225 B.H.P. WORTHINGTON-SIMPSON HEAVY OIL ENGINE

Other exhibits displayed by Worthington-Simpson, Ltd., include a wide variety of the firm's well-known manufactures, such as boiler feed pumps, centrifugal pumps, vertical simplex pumps, and horizontal duplex pumps, both for land and marine work.



FIGS. 71 AND 72—DOUBLE ACTING MOTOR DRIVEN PUMPS—WORTHINGTON-SIMPSON

An example which we have chosen for illustration is the set of vertical double-acting piston motor-driven pumps—shown in Figs. 71 and 72. The particular

set of pumps shown is one of a number which have been specially designed for dealing with tar and ammonia liquors. For this work either the firm's patented stream-line valves or annular valves of the double-beat type are used. It will be noted that the pumps are particularly robust in construction, with easily accessible valves. The gearing is machine-cut with involute teeth, and designed to be silent in running. This type of pump has also been successfully employed for marine work, and is recommended by the makers for ships on which electrically driven auxiliaries are used. The marine pump can be built for oil fuel transfer, ballast, general service, fresh water and other services.

C. A. Parsons and Co., Ltd.

Although to the best of our knowledge this is the first Exhibition at which C. A. Parsons and Co., Ltd., have shown a static transformer, the company undertook work of this nature many years ago. As far

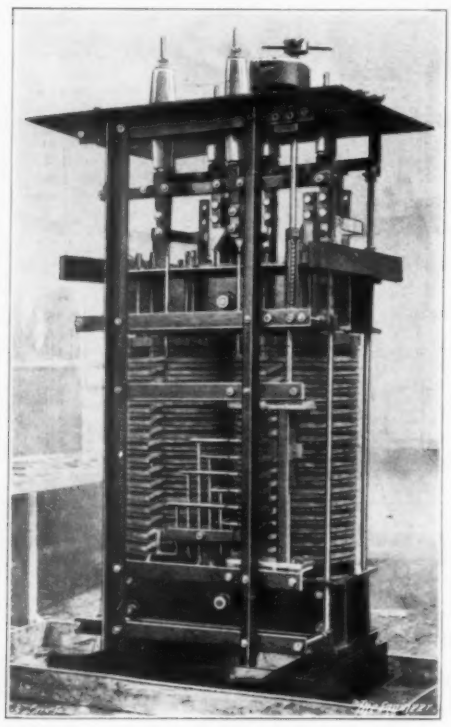


FIG. 73—STATIC TRANSFORMER—PARSONS

back as 1899 the firm manufactured a shell type transformer for the Scarborough Electric Supply Company, and it has been in service ever since. It was designed for a pressure of 2000/210 volts, and for an output of 40 kilovolt-ampères at 80 cycles per second. The core and windings were immersed in a cast iron tank with corrugations—a form of construction which at the time was new. At the Exhibition a modern Parsons 5500/508-volt 40-cycle transformer—as illustrated in Fig. 73—is shown. In practice this oil-cooled transformer is placed in a boiler plate tank, with external cooling tubes, and to the high-tension windings an externally operated tapping switch is connected to enable the low-tension voltage to be adjusted without opening the tank. Modern transformer practice is exemplified by the use of disc type high-tension coils, the provision of numerous oil channels to ensure uniform temperatures in the windings, the use of paper-insulated conductors, "Bakelite" cylinders, separators, &c., and by clamping the windings to resist short-circuiting forces. The active material used per kilovolt-ampère is only 7 per cent. of that of the old transformer.

A small geared turbo-generator set—shown in Fig. 74—is another of C. A. Parsons' exhibits. It is suitable for ship lighting and for other purposes which only call for a relatively small amount of electrical power. With an output of 100 kilowatts at 220 volts, the set is the smallest but one manufactured by the company. It runs at a speed of 3000 revolutions per minute, the actual turbine speed being 10,000 revolutions per minute. The dynamo will carry an overload of 25 per cent. for two hours. The gear wheels, manufactured in accordance with the Parsons "creep" process, are said to be very silent when running. A spring-loaded governor of the Hartnell type, driven through skew gearing, regulates the speed of the turbine, and the throttle valve is operated directly without the use of an oil relay. Impulse blading made of rustless iron is used throughout, and in the case of the machine exhibited, the blading is designed for a steam pressure and initial superheat temperature of 200 lb. and 162 deg. respectively and a vacuum of 27½ in., although it can, of course, be modified to suit other steam conditions. On test the machine was found to have a steam consumption of 19·8 lb. per kilowatt hour, a result which is quite good for so small a plant. The total weight of the set is 2⅔ tons, including the bedplate, in which the oil reservoir and oil cooler are incorporated. The overall length of the set is 9ft. 1½in.

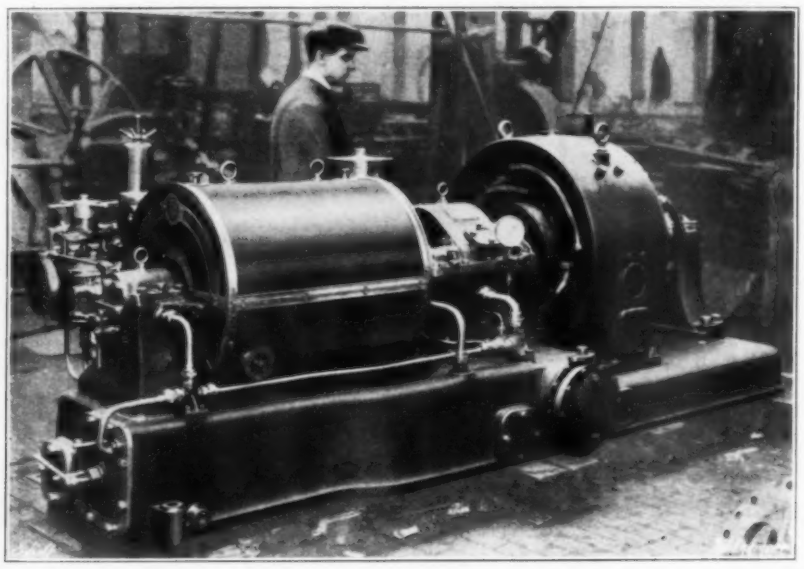


FIG. 74—100 K.W. TURBO-GENERATOR—C. A. PARSONS

Various kinds of searchlight reflectors and silvered glass mirrors, which have been among the company's standard products since the foundation of the Heaton Works in 1889, are on view. There are parabolic reflectors, with diameters ranging from 5½in. to 5ft., and a split parabola-ellipse reflector mounted so that two beams can be obtained at any desired angle to one another—a type of reflector that is specially suitable for the navigation of canals, etc., by night. It is necessary under these conditions to have a beam which will light up the buoys at the sides of the channel and at the same time leave a dark centre, so as to prevent the pilot of an approaching vessel being dazzled by the light from the projector. Among the company's small exhibits are examples of the most recent reaction blading, consisting of steel blades manufactured integral with their roots, by a new rolling process recently perfected by the company.

Birmingham Small Arms Company.

The only production of the Birmingham Small Arms Company on view at the Exhibition is the line-throwing gun, illustrated in Fig. 75, which is intended for the same service as the old-fashioned rocket apparatus used on the occasion of wrecks, but is much more accurate in its aim. As will be seen from the engraving, it comprises an ordinary gun of the sporting type, over the barrel of which there is slipped a canister containing a coil of the line to be thrown. Into the muzzle of the gun there is thrust a long rod, to which there is attached at the front a tube that envelops the front end of the barrel. This rod forms a projectile which is shot out by the charge in a special cartridge. When it is desired to throw the line, a cardboard tube that forms a core round which the line is wound, is pulled out, and the end of the line is attached to a bridle on the projectile. The gun is fired from the shoulder, and produces no more recoil than an ordinary sporting gun. The most effective elevation is 30 deg., and in that position it will carry a $^{3}/_{16}$in. diameter line to a distance of 70 yards. Such a line has a breaking load of 400 lb., and obviously can be of considerable service in itself, or, alternatively, it may be used as a means of hauling in a heavier rope to do the actual work required. The weight of the gun, with the canister and projectile in position, is 22½ lb. Alternatively to being fired from the shoulder the gun can be fitted up on a swivelling stand, with a recoil action, and then the range is increased to 100 yards, while the weight is only 42 lb. The variety of uses to which such a gun can be put will be readily appreciated, for, besides its employment for life-saving at sea, it would be very serviceable in getting out mooring ropes and might possibly help a steeplejack in getting his first fastening into place.

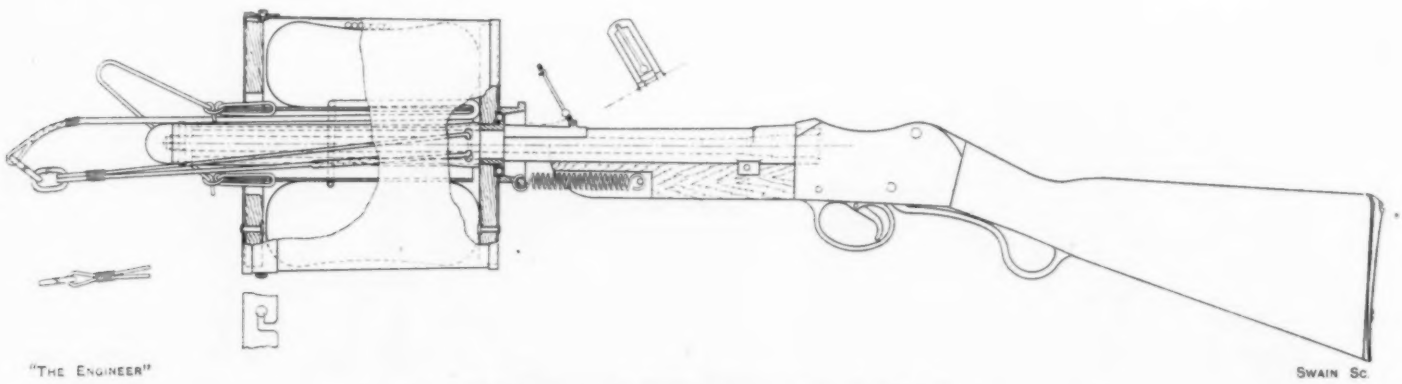


FIG. 75—LINE-THROWING GUN—BIRMINGHAM SMALL ARMS CO.

A Seven-Day Journal

French Submarines.

THE suggestions made in Great Britain and elsewhere for the suppression of submarines have been widely discussed in France, and while sympathy is expressed for the losses sustained by the British, American and Italian navies, there is no desire to see a proposal of this kind put forward officially. Although the French have modified their ideas concerning the value of underwater craft since the days when Admiral Aube foreshadowed the total eclipse of battleships by the creation of large flotillas of submarines and torpedo boats, they still have faith in the submarine, which has for many years figured prominently in the programmes of naval construction. That faith is largely based upon necessity, for in the present state of the country's finances there can be no question of building squadrons of battleships, and the only vessels that can be provided with the resources at present available are light cruisers, submarines and torpedo boats, together with aircraft. There can be no question of suppressing submarines except by disarmament, and the French still hold to the opinion that such disarmament is only possible when the control of the world's naval forces is handed over to the League of Nations. They do not agree that the submarine necessarily entails more risk than aircraft or other weapons in their initial stage, and while the recent losses are deplored, it is argued that the submarine may, in the end, be developed into a trustworthy and powerful instrument of defence. These ideas have taken such deep root in France that the acceptance of any proposals to abolish submarines appears to be very remote.

Wrecks.

LLOYD'S REGISTER Wreck Returns for the second quarter of this year, which have just been published, show that the gross reduction in the mercantile marine of the world, from all causes, during that quarter, was 218,560 tons, and this amount was fairly equally divided between those vessels which were deliberately broken up and those accidentally lost, the proportion being of the order of 118 to 99. It is also noteworthy that much the same relation persisted if the two causes were apportioned out between steamers and motor ships, and sailing ships separately as two classes. In view of the great preponderance of British shipping throughout the world, it is gratifying to find that the British losses, in tonnage, were in no greater proportion than 18 to 80, as compared with all other countries. For all ships, whether lost or broken up, the British losses were 41,666 tons, as against 176,894 tons for other countries. Put another way, the losses of steamers and motor ships to Great Britain were 0·1 per cent. of the total owned. Greece was the most unfortunate country in this respect, with a loss of 0·75 per cent.; while France and Germany were lucky with only 0·02 per cent. each. It is noteworthy that when we come to sailing vessels, British ships were much better than those of any other country, with a loss of 0·4 per cent. An unusual entry in the detailed part of the return concerns the "loss" of the ss. Corvallis, of 2922 tons, an American wooden screw steamer, which was "destroyed for film purposes."

Electric Power Supply.

DURING a speech at the annual dinner of the British Electrical and Allied Manufacturers' Association, Lord Weir made some remarks which support a policy in connection with the generation and supply of electricity that has been advocated for some time past. He naturally pressed for a reduction in the cost of electricity supplies, and said that we appeared to possess inherent possibilities for producing and distributing electricity at cheaper rates than any other great industrial country. He did not, however, think that the desired result could be attained by any drastic policy of shutting down existing stations and constructing a small number of huge plants at the pithead. What was most essential was, he said, that any new electricity scheme should be so devised as to enable coal pre-treatment processes to be dovetailed into the new scheme readily and naturally. A much more immediately important development, although a smaller one, was the full utilisation of waste heat, such as that from coke ovens in the generation of power which could be transmitted to the consumers by high-tension mains.

Heavy Oil Engine Working Costs.

A DRAFT report on the subject of the working costs of heavy oil engines during the year 1924–5 was considered at a meeting of the Diesel Engine Users' Association, held on Friday, the 20th inst. The report is the fourth of the series which has been issued by the Association, and it gives particulars of thirty-six Diesel engine and hot-bulb installations in the United Kingdom and eight Diesel engine operated generating stations overseas, as well as comparative running costs for steam engine and oil engine driven pumping plants in Egypt. The average total engine costs of the thirty-six home stations, with a total output of over 32,000,000 units and a plant load factor of 15·3 per cent., were 0·806 penny per unit generated during the period under review. Last year's figure was 0·899 penny and the improvement is largely accounted for by the reduction effected in maintenance costs. The average total engine costs for the eight stations overseas, with a total output for the year of over 18,000,000 units, was 0·746 penny per unit generated. In the discussion, it was rightly pointed out that the conditions of load factor under which most of the plants worked gave results which were hardly comparable with those obtained from heavy oil engines operating under reasonably favourable conditions. A feature of interest is that the capacity of the nineteen new plants put down during the year averaged well over 500 brake horse-power each, there being four engines of 1000 brake horse-power and upwards, and four of 750 brake horse-power. The movement in the direction of larger oil engine driven generating units would seem to have been maintained during the year. Progress has also been recorded in the direction of reducing the amount of lubricating oil used, by centrifugal and other means of purification, but very little has been done in connection with the use of low-grade fuel oils and the utilisation of the waste heat in the exhaust gases and the heated cooling water.

The Fate of Submarine M 1.

THE mystery surrounding the fate of submarine M 1, which disappeared on November 12th, while exercising off Start Point, has been cleared up by a statement emanating from the master of the Swedish steamship Vidar. This vessel, it appears, was in the neighbourhood of Start Point on the morning of November 12th when two distinct shocks were felt. These shocks were at first attributed to heavy seas striking the ship, but when Captain Anell heard on arriving at Cuxhaven that a British submarine had been lost off the Devonshire coast, he thought it well to communicate his experience to the Swedish naval authorities. An inspection of the ship's hull at Stockholm has established the fact that she had been in collision with some obstruction, and in view of the coincidence of time and place, and the fact that marks of grey paint have been found on her hull, no reasonable doubt exists that the Vidar was the unwitting destroyer of M 1. In the Admiralty's opinion, the submarine was rapidly and completely flooded, and the crew must have perished immediately. It is some consolation to know that the loss of the boat was not caused by a mechanical defect, but the failure of the Swedish vessel to receive any warning as to the presence of submarines in the area through which she was steaming has yet to be explained. This case is the third within the past three months of a submarine having been run down and sunk by a merchant vessel, the previous victims being the Italian boat Veniero, lost off the Sicilian coast on August 26th, and the American boat S 51, sunk in Long Island Sound on September 25th. No success has, so far, attended the diving operations to locate the wreck of M 1, and it is thought likely that the attempt will be abandoned.

Wireless Transmission of Energy.

THE fact that in the new Wireless Act reference is made not only to the transmission and reception of messages, but also to the transmission of energy, has led many people not fully acquainted with the scientific side of the art to suppose that the day when power will be transmitted through the ether in useful quantities is near at hand. Such transmission can be effected at the present moment, but the amount of energy which can be so sent is very small, and the efficiency of the process is very low, so much so that for the time being there is really little evidence warranting the belief that the wireless transmission of energy on a practicable scale is a probable development of the near future. Speaking on this subject at a dinner last week of the Radio Association, the chairman, the Duke of Sutherland, referred to the visions of "the camp-followers of science" in which wireless power stations were used for driving factories, trains, motor cars and aeroplanes. In view of the present position of wireless, he said such visions were neither scientific nor intelligent; like a certain "death ray" they were "mere moonshine." The most important problem to solve in connection with this development of wireless was, he said, to discover means of transmitting the energy in one particular desired direction, and not broadcast in all directions. That problem was being actively studied in the realm of wireless telephony, but not until it had been solved in connection with the wireless transmission of energy would the wonders forecast by the pseudo-scientists come within the range of probability.

The Development of Coal Dust Explosions.

A REPORT published this week by the Safety in Mines Research Board on the effect of release of pressure on the development of coal dust explosions is of much more practical importance than its title at first sight would suggest. The experiments described were conducted at Eskmeals with the object of determining to what extent a coal dust explosion was aided or retarded by a release of the pressure, either at the point of origin of the explosion or at some point in its path, such as would be caused in a mine roadway by openings to side galleries or drifts. It was found that if the release of pressure behind the point of ignition were prevented, the conditions were more favourable to the inception of a coal dust explosion than they were if the pressure were partly or wholly released. The effect of openings along the path of an explosion was found to be mainly to release the pressure. With the openings ahead of the flame the velocity was increased, but with them behind the flame the velocity was decreased. A study of the report should not only assist the investigation of colliery explosions, but should indicate the positions in mines at which the measures taken against the accumulation of coal dust or the occurrence of a source of ignition should be most stringent. For instance, it is clear that there is less danger of a coal dust explosion developing from a given source of ignition at a long-wall face than at a dead end or *cul-de-sac*. The experiments described in the report were conducted by Dr. R. V. Wheeler, the Director of the Eskmeals station, and Mr. H. P. Greenwald, Assistant Physicist on the United States Bureau of Mines staff. The report is the second joint publication to be issued in connection with the scheme of co-operation now in existence between the two countries. The experimental gallery at Eskmeals has recently been demolished, but the experiments dealt with in the report are to be continued at a new station at Harpur Hill, near Buxton.

The Exhibition at Olympia.

THE Shipping, Engineering and Machinery Exhibition at Olympia, to which we devoted a special Supplement in our last issue, was declared open on Monday last by Mr. Bridgeman, First Lord of the Admiralty. Speaking from the reception space in the centre of the hall, Mr. Bridgeman said he desired to express on behalf of the Admiralty its gratitude to the inventors and industries represented at the Exhibition for all they had done for the British Navy. It was the policy of the Admiralty to keep the Navy in line with the most modern ideas, and not to send to sea any ships which were inferior to those of other countries. He recognised particularly the value of the research work on which engineers were engaged, and, alluding to the loss of M 1, added that the Admiralty sought to make it impossible, as far as human ingenuity would allow, for accidents to occur from causes within its control. Subsequently, a luncheon to a very large number of guests was served in the new restaurant. At it Sir Charles Parsons presided, and Sir Walter Runciman was the first speaker. In proposing the health of "Shipping and Commerce," he asserted that those who were responsible in this country for shipbuilding undertakings would rather rely upon their own enterprise than upon any form of State help. He dreaded any recrudescence of Government interference in industrial affairs, and he felt confident that if left to themselves business men would survive the present depression and be ready to meet a great expansion of trade of which he already saw signs. At the general wish of the assembly, Mr. Bridges, organiser of the Exhibition, made a short speech in acknowledgment of "Success to the Exhibition," proposed by Mr. W. J. Berry, Director of Naval Construction.

An Oil Tank Explosion.

THE explosion which took place on January 14th, 1925, in a new oil tank at the works of the Medway Oil and Storage Company, Ltd., Isle of Grain, Kent, would seem, according to the Home Office report just issued upon it, to possess features of considerable general interest. The tank was 102ft. 6in. in diameter and 30ft. in height. During its construction it was tested for tightness by pumping water into it. On the day of the disaster the water level was within 2in. of the top, which by that date had been roofed over. An air pressure test had been carried out, and an examination for leakage was being conducted. During this examination a boilermaker was instructed to put a $\frac{5}{8}$in. rivet in a hole in the curb angle at the top of the tank. When the rivet was about to be inserted in the hole there was a flash of flame, and with a dull heavy boom the whole roof of the tank was blown off. One fragment, weighing 8000 lb., was hurled to a distance of 180ft. Three men lost their lives. Mr. G. S. Taylor, Senior Engineering Inspector of Factories, in his report attributes the explosion to an accumulation of petrol and petrol gas above the water in the tank, the ignition being caused by the heated rivet. How the petrol reached the tank is scarcely in doubt. It seems that the water used for testing was drawn from the river Medway by a pump which between the tests was used for its ordinary duty of delivering petrol to vessels in the river. Although certain precautions were taken to free the pump and the pipes connected with it from petrol, there is little doubt that some remained behind, adhering to the walls or trapped in bends, &c., and that with each fresh delivery of water additional petrol, totalling probably something in excess of 22 gallons, was sent into the tank.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XLVIII.*

PERIOD 1901 TO 1914 (*continued*).

LOCOMOTIVE DETAILS, 1901–1914.

Boilers.—Following J. F. McIntosh's example of 1896, other engineers increased the diameter of boilers. Previously the size of the cylinders seems to have been the principal factor in estimating the power of a locomotive, but henceforth the boiler began to be the first consideration, though progress in this direction was gradual.

More attention was paid to water capacity, steam space, and circulation, and narrow water spaces were enlarged. Perhaps the most marked developments took place on the G.W.R. under Mr. Churchward's supervision. After W. Dean had adopted the Belpaire fire-box casing raised above the barrel, which was made in two rings, the second ring was coned so that the top joined the fire-box casing and simplified the flanging necessary for the raised casing. This was another form of the American wagon top boiler. Afterwards the front ring was also coned. The design provided a greater area at the water line, larger steam space, and increased water space at the sides of the tubes.

On the L. and Y.R., H. A. Hoy in 1902 built a number of mineral engines with steel corrugated Cornish flues in place of copper fire-boxes. Drawings appeared in THE ENGINEER, August 15th, 1902. The principle was similar to that of the Lentz boilers in Germany, and of the Vanderbilt type in the U.S.A. The design has been abandoned. Particulars of the service and defects of these boilers were given by Mr. G. Hughes, Proc. Inst. Mech. Engineers, February, 1906, and July, 1909.

The only water-tube fire-box of the Brotan type was made by Beyer-Peacock in 1907 for a four-wheeled industrial tank engine. See THE ENGINEER, January 10th, 1908.

In 1902 six passenger tank engines on the L. and Y.R. were provided with Druitt-Halpin's thermal storage system, consisting of a cylindrical vessel mounted above the boiler and connected to it by saddle plates. The object is to cause the excess of power generated in the boiler, over that required for immediate consumption, to be stored as steam and hot water for use when extra power is demanded. Drawings appeared in the "Proc." Inst. Mech. Eng., July, 1909. On a heavy road with frequent stopping places, the saving was stated by Mr. G. Hughes to be 12 per cent., but when the engines took their turn on other sections the all-round economy was 4 per cent.

Superheaters.—By far the most notable landmark in locomotive progress during the present century is high degree steam superheating. Sir John Aspinall's superheater of 1899, placed within a chamber recessed into the boiler barrel immediately behind the smoke-box, produced a superheat up to 95 deg. Fah. From a modern standpoint it would be considered as a steam dryer; nevertheless it was a very efficient one. The practical application of high temperature superheating was due to Wilhelm Schmidt, of Cassel. His first two designs, which were tried in Germany in 1898 to 1900, were never used in this country. The present well-known form was applied by M. Flamme, in Belgium, and particulars were given in the "Proc." Inst. Mech. Eng., June, 1905. The first Schmidt superheaters on a British railway, as far as the writer can trace, were fitted by Mr. G. Hughes in November, 1906, to two goods engines on the L. and Y.R. They were followed by Mr. D. Earle Marsh's 4–4–2 express tank engines on the L.B. and S.C.R. early in 1908. The principle of Schmidt's smoke-tube superheater has been followed in various designs, such as the Robinson, Gresley, Swindon, Eastleigh, Horwich, &c., which have been illustrated in THE ENGINEER. D. Drummond, on the L. and S.W.R., contented himself with a couple of short cast steel boxes in the smoke-box, forming a steam dryer, much less efficient than Aspinall's, as the superheat amounted to only about 20 deg. Fah. Other more elaborate forms of smoke-box superheater, such as the Phœnix, were tried, and abandoned.

Feed-water Heating.—F. H. Trevithick's classic experiments, from 1901 onwards, on the Egyptian State Railways, led to a revival of feed-water heating and with it the use of independent feed pumps. Trevithick utilised both the exhaust steam and smoke-box heaters in series. Contemporaneously D. Drummond arranged under the tender tank a long cast iron box containing a series of pipes, into which the exhaust steam was turned. Subsequently he added a smoke-box coil in series with the tender heater.

Boiler Accessories.—The top feed through the steam space is of ancient origin. In 1863 G. Spencer patented a feed water purifier. A chamber into which feed water was admitted was in communication with the steam space and contained a number of trays, one below the other. The feed water was delivered on to the top tray, whence it descended on to those below in series, finally falling through the steam space into the boiler. An almost similar arrangement was applied from 1863 onwards by Herr Wagner, locomotive engineer of the Bergisch-Märkische Railway, Germany, and was illustrated in THE ENGINEER, January 16th, 1867. M. Chapsal applied a very similar arrangement in France about 1890. In this country the top feed had been forgotten until history again repeated itself, and in the discussion on Mr. G. J. Churchward's paper on "Large Locomotive Boilers" (Inst. Mech. Eng., March, 1906), Mr. Vaughan Pendred suggested putting the feed into the steam space. Mr. Churchward then stated that he intended to pursue the plan, and the G.W.R. system of top feed resulted. The apparatus is similar to that of 1863, but instead of a second "dome" to contain the trays, in Churchward's design two parallel trays are placed inside the boiler under the safety valve seating, to the sides of which the clack boxes are fixed. The delivery pipes are external. In Mr. R. E. L. Maunsell's S.E. and C.R. engines of 1917 the dome-shaped chamber outside the boiler reappeared, and the water flows down a helical tray inside this chamber, finally dropping on to a saddle fixed to the perforated steam pipe.

Variable blast-pipes of different designs came more extensively into use. Several took the form of a cone which could be raised or lowered inside the orifice. These were regulated from the footplate, but in T. Whitelegg's London, Tilbury and Southend engines, built in 1909 by R. Stephenson and Co., the cone was actuated automatically when notching up by means of a bell-crank lever worked by a rod connected to the reversing gear through the medium of a slotted link. Blast-pipes with internal regulating cones are ancient history, and appear in Rothwell's engine of 1832—see Fig. 15 *ante*. They reappeared about forty years later on the Continent, where several designs were in use in Germany about 1870. After another long interval they found their way back to this country.

A most ingenious and successful automatic variable blast-pipe is the "Jumper," applied by Mr. Churchward to the G.W.R. engines. The "jumper" is a loose collar with a projection which rests upon a ledge on the outside of the orifice. The orifice has sixteen 1in. holes round its circumference, through which the excess of exhaust steam passes when the blast is heavy. This steam acts upon the top flange of the "jumper," which is lifted, thereby increasing the effective area of the orifice.

Various novel kinds of spark arresters appeared during the first few years of the present century. Their use till then had been very limited in this country, and the types employed had consisted of a wire gauze screen disposed either as a horizontal diaphragm across the smoke-box, or an inverted cone extending from the top of the blast-pipe to the base of the chimney. The new arresters took the form of baffle plates arranged in various ways in the smoke-box. In D. Drummond's arrester perforated baffle plates were fixed to movable wings hinged to the blast-pipe, so that they could be moved aside when the tubes were being cleaned. In McIntosh's arrangement a plate V-shaped in plan is fixed between the tube plate and the blast-pipe, with the addition of an inclined deflector plate, the latter being similar to the American "diaphragm" plate. Additional louvre baffles are fitted to the front of the smoke-box. To prevent accumulation of ashes in the angle of the V plate at the bottom of the smoke-box a 3in. draught pipe with its lower end near the base of the blast-pipe and its upper end in the bottom of the chimney is arranged inside the angle of the V plate. This system was applied to many of the Caledonian Railway engines.

Frames, Axles, Bogies, &c.—On the G.W.R. Mr. Churchward in 1903 adopted a composite frame, of which the front end consists of a ⊿-shaped slab, which is bolted to the main plate frame in front of the first coupled axle. The slab is similar to the form used in the latest American practice, being a compromise between a bar and a plate. It lends itself to the attachment of the outside cylinders, which, with their steam and exhaust passages, are in modern G.W.R. practice also based upon American designs. See drawings in THE ENGINEER of May 13th, 1904.

Though not universally used, built-up crank axles with balance weights formed as extensions of the crank webs superseded forged crank axles for heavy engines on several railways. On the G.W.R. and the L. and Y.R. pendulum link bogies were abandoned. The former had tried the three-pin and the latter had used the two-pin arrangement of swing links. The spring-controlled sliding bogie proved that a much steadier riding engine resulted. The later G.W.R. bogie is a combination of British, French, and American features. It is of the sliding type controlled by two helical springs, as in R. Stephenson and Co.'s design of 1861. The weight is not carried on the pivot, but the Alsatian design is followed, in which the bearing of the main frame rests on a spherical seating at each side. Finally, the bogie frames are of the American bar construction. Incidentally these are the only bar frames in British railway practice, but a bar-framed bogie, somewhat similar to a diamond truck, has recently been supplied to one of the smaller "Atlantic" express engines of the G.N.R. type, "3990" class, on the L. and N.E.R. The axle-boxes and bearings are outside.

The bogies of the later N.E.R. engines are provided with Timmis's spiral bearing springs. Those of the leading wheels have a greater deflection per ton than those of the hind wheels, the respective rates for the 4–4–2 express engines being .535in. and .375in. per ton, the object being to make the front end adapt itself more readily to the inequalities of the track. This is, in effect, P. Stirling's idea of 1870 carried out in a different manner.

Brakes on leading-bogie wheels were adopted on the G.W.R. and subsequently on the Midland Railway, and they were also fitted to the L. and Y.R. 4–6–0 engines in 1908. Mr. Hughes, in his report to the 1922 Congress of the International Railway Association, stated that on the L. and Y.R. they were afterwards discarded as the "brake tended both to stiffen the bogie wheel base and impede the free rotation of the wheels, thus increasing the tendency for them to mount the rail. As one of the functions of the bogie is to guide the engine round curves, it was considered advisable to keep it as flexible as possible." There is considerable difference of opinion on this subject, and the G.W.R. and M.R. engines still retain bogie brakes.

A novelty in two-wheeled pendulum link pony trucks was introduced by Mr. H. N. Gresley on the G.N.R. in 1912. It is shown in the drawings of the 2–6–0 engine in THE ENGINEER of November 28th, 1913. The single bolster is replaced by a double one the top portion being inverted. The object is to equalise the weight on the truck wheels when passing round curves; at the same time the lateral tilting of the body of the engine with a two-pin single pendulum bolster is avoided.

Cylinders and Valves.—After the 1849 experiment on the S.E.R., the uniflow system was not revived for locomotives until Stumpff took it up in Germany about 1909. The N.E.R. 4–6–0 engine with uniflow cylinders, of which drawings appeared in THE ENGINEER, April 18th, 1913, was built in February of the same year. The weight, 71.7 tons, of the engine was 2.85 tons more than that of the otherwise similar standard engines.

The method of supporting the smoke-box in a saddle forming part of the cylinder casting, as has been the American practice for many years, was introduced by W. Dean on the G.W.R. at the end of 1899 for inside cylinders. In 1902 the design was used for the first G.W.R. 4–6–0 express engine, with outside cylinders, and has since gradually spread to other railways.

When the G.W.R. first tried piston valves, the old solid plug type was adopted, though it had been discarded many years previously. But to avoid trapped water spring-loaded relief valves were fitted to the cylinder covers. Eventually the plug valves were abandoned by the G.W.R., owing to leakage of steam past them.

The various designs of piston valves are too numerous to describe in great detail. The most original design is that of Mr. G. Hughes on the L. and Y.R., in which passages through the piston valve heads form communications between the cylinders and the steam chests. These passages are closed by steel balls, which are held on their seats by the steam chest pressure. When the back pressure in the cylinders rises above the steam chest pressure, the balls fall from their seats and relieve the former—see drawing in THE ENGINEER, November 21st, 1924. Mr. J. G. Robinson's piston valve effects the same purpose by means of a flat annular valve, which covers a number of holes drilled circumferentially through the head, corresponding holes being drilled radially through the solid ring, the latter registering with a third series of holes in the main packing ring. The annular valve opens the passages through the holes when the pressure in the cylinders is in excess of that in the steam chest. Both these piston valves do away with the necessity for release valves on the cylinder covers.

Motion and Valve Gears.—In 1902 the G.W.R. provided the connecting-rods of the first outside cylinder 4–6–0 engine with big ends having solid bushes, and all the standard engines with outside cylinders have this form of rod, which has spread to several other railways.

Deeley's valve gear has already been mentioned. A valve gear by J. T. Marshall, of Leeds, was fitted in 1902 to a Great Northern goods engine, and subsequently to a 4–4–0 passenger engine. Unlike many other valve gears, in which at least one excentric is suppressed, two excentrics were used. A full description of the gear, as fitted to a 4–4–0 engine on the G.S. and W.R., Ireland, was given in THE ENGINEER, November 3rd, 1905.

In 1912 Mr. H. N. Gresley adopted a modification of the usual form of Walschaerts gear. The weight of the combination lever and the front end of the radius rod is carried by a small crosshead, which slides in an extension of the back cylinder cover. This arrangement replaced the valve spindle tail rod and its guide. The back end of the radius rod, instead of being connected by a link to an arm of the reversing shaft, is extended to a point behind the quadrant link and carried on a slipper block attached to an arm at the end of the reversing shaft. This arrangement reduces the slip of the block in the quadrant link. Subsequently, Mr. Gresley applied ball bearings to the return crank.

To the G.N.R. "Atlantic" engines, which have a reversing lever with notched sector, H. A. Ivatt in 1900 applied an arrangement to maintain the reversing shaft rigid, and prevent the rattling movement which frequently occurs. A small friction drum in

* No. XLVII. appeared November 20th.

halves is keyed to the reversing shaft. On the back of the cross stay is fastened a cast iron strap, which embraces half the circumference of the drum. The movable portion of the strap, embracing the other half circumference, is of wrought iron and is tightened by means of a link and lever attached to the piston-rod of a 6in. vacuum cylinder.

The adoption of superheating made it necessary to pay particular attention to the lubrication of cylinders and valves, and mechanical lubricators became extensively used, though on several railways sight-feed lubrication is found to be quite efficient. Without making any definite statement, the writer thinks that mechanical lubricators were first used in Germany, where several forms were to be found at the beginning of this century.

Locomotive with Multiple Single-acting Cylinders.—In 1908 a novel type of large "freak" locomotive was constructed at one of the railway works in this country, though the chief mechanical engineer of the company was not responsible for the design. The engine was of the 2–6–2 type, having a pony truck at each end. There were eight single-acting cylinders with trunk pistons disposed in two groups of four, each group formed of a single casting. One group was placed between the front and the middle, and the other between the middle and the back coupled axles. The inner ends of the two cylinders on the same side of each group communicated with one another, the two pistons moving in opposite directions, but the bores were out of line and arranged excentrically to allow of suitable arrangement of the cranks of the middle axle. This axle had four inside cranks, two driven by pistons of the front and two by those of the back group. The front and back coupled axles each had inside cranks driven by the remaining two pistons of each of the respective groups. The movements of pistons and cranks were such that the whole were balanced.

The total width of cylinder castings was such that main frames inside the wheels were not possible, and outside frames only with outside coupling rod cranks had to be used.

Each of the two cylinder groups had a single circular steam chest situated above it with its axis on the longitudinal centre line—in plan—of the engine. This steam chest had a bronze sleeve, through which two admission ports were made one quarter of the circumference apart, one port communicating with the two right-hand, and the other with the two left-hand cylinders of the group. Since the two cylinders were practically equivalent to one with the trunk pistons back to back, the steam admitted through one of these ports entered between the pistons and moved them in opposite directions. The steam chest contained a circular cast iron sleeve valve, which rotated continuously. As the port in the valve passed over the two ports in the steam chest in turn, steam was admitted to the right and left-hand cylinders.

The exhaust took place when the pistons overran ports in the cylinder walls, as in the uniflow system, the exhaust steam from each group of cylinders passing into a longitudinal pipe, through which it was conducted to the blast-pipe in the smoke-box.

The two sleeve valves, one for each group, were fixed on a longitudinal shaft, which derived its motion from the two coupling rods. The latter were extended to drive outside cranks fixed on a transverse lay shaft, from which motion was communicated through bevel gears to an intermediate shaft, and the latter, in turn, actuated the longitudinal valve shaft through another pair of bevel wheels.

Reversing was effected by means of a differential gearing interposed in one of the shafts, somewhat after the "jack-in-the-box" type with four bevel wheels. By rotating the box by means of gearing worked from the cab, the rotary valve shaft was advanced relatively to the lay shaft, and the position of the valve with respect to the sleeve altered. The cut-off was altered by means of an arrangement whereby the driver could rotate the sleeve in the steam chest relatively to the ports in the main casting.

The middle driving axle had four inside cranks formed by bending it; the front and back driving axles each had two inside cranks, of Z form. The piston strokes were very short, the crank radii being only about 6¼in. long, less than the diameter of the crank pins, so that the connecting-rod big ends were kinematically equivalent to excentrics.

The boiler also had its peculiarities. The fire-box had an extremely wide grate extending laterally over the frames, and two fire-doors were provided. Instead of side and back water spaces a fire brick lining was substituted, somewhat on the principle of the former Hungarian Verderber fire-box. The smoke-box was provided with a hopper, from which the ashes could be ejected.

This remarkable locomotive ran only a few trial trips. It failed chiefly on account of the sleeve valves, which either leaked badly and caused the engine to be enveloped in a cloud of steam, as when the writer saw it, or the bronze sleeve seized so badly as to render the engine immovable.

The cylinder arrangement was covered by patent No. 23,714 of 1904, and the rotary valve by patent No. 14,488 of 1905, but the general arrangement of the engine as built and described above, and the method of driving the valves from the coupling rods instead of through chains and spur gearing, differed very considerably from the 1904 patent drawings. In the latter the two cranks of the middle axle on one side of the centre of the engine are shown at 90 deg. to one another and at 180 deg. with the corresponding cranks on the opposite side.

The Shipping, Engineering and Machinery Exhibition.

No. II.*

We continue below our account of the exhibits at the Shipping, Engineering and Machinery Exhibition at Olympia.

Liptak Furnace Arches, Ltd.

The principal exhibit on the stand of Liptak Furnace Arches, Ltd., of 38, Victoria-street, London, S.W. 1, is an arch built over a Bennis chain grate stoker for a Stirling boiler, of which we give a drawing in Fig. 23. In our issue of March 27th last we gave a full description of one of these arches, as applied to a Babcock boiler, and the general principle remains the same, although some minor modifications have been made in the latest installations, while there is now added the interlocking mid-feather wall, shown in the lower part of Fig. 23 for the purpose of covering over the space between two adjacent stokers. The arch exhibited, by the way, is only one of two for the boiler in question.

The peculiarity of the Liptak arches lies in the precautions taken to protect the supporting framework from the action of the heat of the furnace, while the brickwork is unusually conveniently arranged for renewal purposes. As will be seen from the drawing, the main support for the refractory blocks is provided by a series of standard rolled joists, which may be carried in any convenient manner, and the whole structure of refractory arch blocks is suspended from this framework. On to the lower flange of the main joists there is slipped a series of cast iron clips or hangers, which are used to suspend transverse cast iron girders. The clips are of a standard shape, and are so formed that the girders can be set at any inclination without alteration. The girders also are standardised, but naturally have to be of a length appropriate to the arch. There are two main shapes of arch block, both of which are shown in the detail sketch of Fig. 23. The upper of these two blocks rests on the lower flanges of the cast iron girders, and has a depending T-shaped head. The lower blocks have corresponding T heads, which fit between the upper blocks, and corrugated sides. A few special blocks are, of course, necessary for finishing off the sides and ends of the arch, but only a comparatively limited stock of bricks is needed for repair purposes.

It would naturally be possible to form a suspended arch with a single thickness of blocks, but the double layer used in the Liptak design has the advantage that the lower blocks can be allowed to waste right away before they need be replaced, as there is still the upper row to protect the ironwork from the flames.

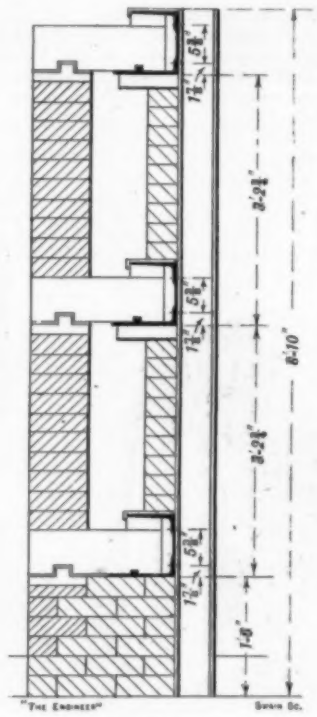


FIG. 24—INTERLOCKING AIR-COOLED WALL—LIPTAK

Tests carried out by the makers show that a thickness of 4in. of fire-brick is ample to prevent the metal parts from becoming dangerously hot.

In erecting these arches, the upper layer of blocks is usually set with high-temperature cement, and the joints are grouted on the top with fire-clay to make them air-tight.

A section of a Liptak interlocking air-cooled wall, as used for the combustion chambers of powdered fuel plants, is also shown on this stand. In this system the inside wall, which is the one subject to high temperature, is divided up into panels. The

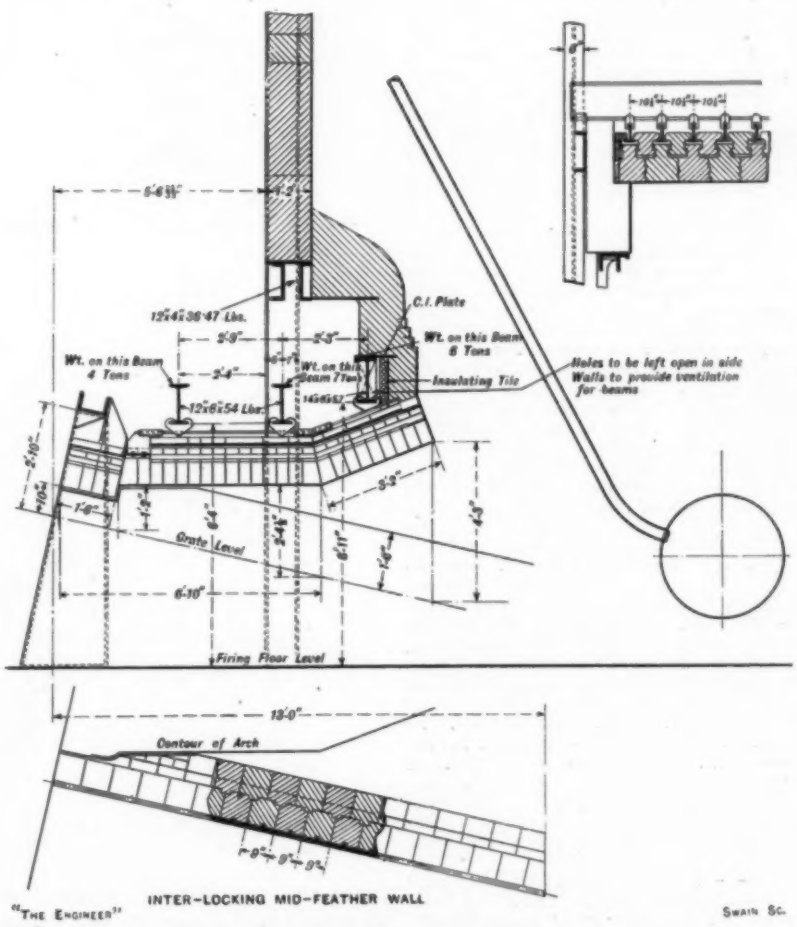

C.I. Plate
Wt. on this Beam 8 Tons
Wt. on this Beam 4 Tons
Wt. on this Beam 7 Tons
Insulating Tile
Holes to be left open in side Walls to provide ventilation for beams
Grate Level
Firing Floor Level
Contour of Arch
INTER-LOCKING MID-FEATHER WALL
"The Engineer"
Swain Sc.

FIG. 23—ARCH OVER BENNIS STOKER IN STIRLING BOILER—LIPTAK

* No. I. appeared November 20th.

weight of the refractories in each panel is taken by special refractory shelf blocks, as shown in Fig. 24, which are mounted in anchor castings attached to the outside steel framework. This arrangement, besides facilitating repairs, provides for the local expansion of each panel.

THE SPERRY GYROSCOPE COMPANY, LTD.

A demonstration of automatic steering provides an exhibit of much interest on the stand of the Sperry Gyroscope Company, Ltd., of 15, Victoria-street, S.W. 1. The Sperry automatic helmsman was shown at the Shipping, Engineering and Machinery Exhibition of 1923, but it has since been considerably developed in order to facilitate its application in motor and other ships in which the steering engine, in common with the other auxiliaries, is electrically driven. In the earlier, or "single unit," design the gyroscopic repeater compass exercised control over an electric motor in such a way that when the vessel moved off its set course the motor was started up and the steering wheel rotated to give the amount of helm requisite to bring the vessel back on to its course. The motor was reversible, and the direction of its rotation was determined by the movement of a trolley to one side or the other of an insulated segment held in a set direction by the gyro compass. The direction of the segment could be adjusted to vary the course of the ship.

It will be gathered that this one-unit form of automatic pilot with its motor driving directly on to the steering wheel replaced the ship's quartermaster without any alteration in the arrangement of the steering equipment. It was simply an addition working on to the ordinary steering wheel and did not affect either that wheel or the steering engine or the telemotor or other arrangement interposed between the wheel and the engine. The fact that the valves or other controls of the steering engine were operated from the steering wheel through the agency of shafting or of a telemotor, introduced the possibility of lost motion and telemotor lag, and therefore rendered the checking of yawing movements less sensitive and instantaneous than it should have been in view of the refined action of the gyroscopic control. For this reason the "two-unit" type of automatic pilot—an example of which is illustrated in Fig. 25—was developed. The unit shown on the right is stationed on the navigating bridge. It is no longer merely an addition to the hand steering wheel, but includes such a wheel as one of its parts. This control unit, as before, supplies the required automatic action through the agency of a gyroscopic repeater compass, but it does not contain the source of power whereby the valves of the steering engine are operated. Its duty is to control the power unit—shown on the left—which is stationed in the steering engine-room and which controls the steering engine valves in a direct manner. The telemotor system, or the equivalent shafting, is thus completely eliminated, the connection between the control unit and the power unit being purely electrical.

A lever on the side of the control unit is provided with three stations marked "gyro," "hand" and "off." When it is moved from the "gyro" to the "hand" position the power unit ceases to be automatically controlled and comes under hand control exercised from the wheel on the control unit. This wheel, it is interesting to note, being somewhat smaller than the ordinary steering wheel, has been furnished with a brake in order that it may be operated with due restraint. Its steering ratio is the ordinary standard one of eight levers to move the rudder from hard over to hard over. The third, or "off," position of the control lever permits the steering to be thrown off the Sperry units and on to the ordinary telemotor and telemotor steering wheel installed as a stand-by. To this end the power unit is connected to the steering engine and to the after telemotor through a magnetic clutch which opens when the control lever is moved into the off position. This clutch also opens if the ship's electrical power should fail. In such an event the telemotor springs are set free to centralise the rudder, and the telemotor steering wheel becomes instantly available for navigating the ship.

Modifications of the system have been devised to suit different forms of steering equipment, including that in which the rudder is operated by a large reversible electric motor directly geared to it.

It is not, we believe, generally realised by those who have had no occasion to study the subject at all closely that wireless direction finding for the purpose of fixing a ship's position at sea is more or less valueless without an accurate knowledge of the point of the compass towards which the ship's nose is pointing. For example, in Fig. 27, let the directions from which signals are received from two stations A and B make the angles α and β respectively with the ship's centre line. These values correspond with the ship being at any point of a circular locus passing through the points A and B on the chart. The ship's position is therefore indeterminate. If, however, the direction of the ship's centre line is known—in the diagram we have supposed the ship to be sailing north-east—then the absolute direction of the lines A O and B O can be laid down on the chart and their point of intersection determined. It may be remarked that the locus is a *complete* circle, but if the sense of the signals as well as their direction can be determined—as is now possible—discrimination can be made between the two arcs into which the points A B divide the circle.

Wireless direction finding, as here exemplified, requires the use of a compass. The accuracy with which it enables a ship's position to be fixed cannot exceed the accuracy of the compass reading. This statement applies to the determination of a ship's position from the ship itself and not to its determination by two shore stations acting in conjunction. The statement also requires qualification in so far as the possible development of the revolving beam system as established at the South Foreland may enable a ship to fix its position without reference to a compass reading. Two such stations with the areas served divided segmentally and distinguished by separate code systems would enable a ship to fix its position—to the extent of its being within a certain quadrilateral area—without reference to a compass. It may further be noted that if the directions of three stations can be observed the position of the ship can be fixed on the chart without reference to a compass reading. This fact permits us, if we so desire, to regard a two-station plus compass determination as being mathematically identical with a three-station determination, the third station being at the North Pole.

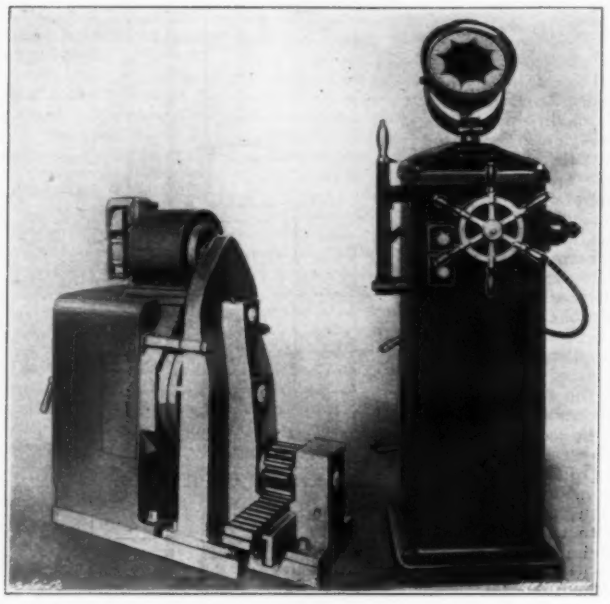


FIG. 25—"TWO-UNIT" AUTOMATIC PILOT—SPERRY

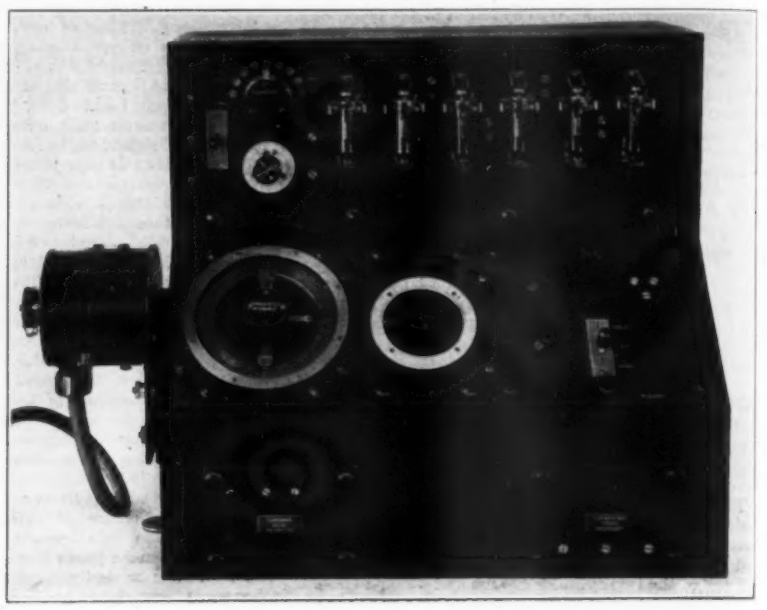


FIG. 26—GYRO REPEATER DIRECTION FINDER—SPERRY—MARCONI

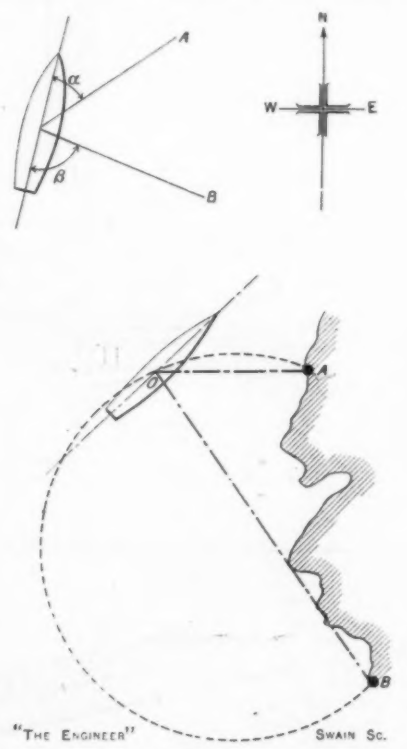


FIG. 27

According to Commander J. A. Slee, of the Marconi International Marine Communication Company, 50 per cent. of the errors made in fixing the position of a ship by wireless bearings are due to errors in the compass or errors made in reading it, that is to say, to factors outside the direction finding equipment by itself. In order to improve matters in this respect the Sperry Gyroscope Company, in co-operation with the Marconi International Marine Communication Company, has designed a gyro repeater movement to act in conjunction with the direction finder. The equipment is such that the wireless operator is enabled to read at sight the true bearing of any observed station. The combined apparatus, as shown at the Exhibition and illustrated in Fig. 26, is claimed to provide a true "wireless compass." The advantages of the system are stated to be particularly important at long ranges, for the error in fixing a ship's position is proportional to its distance from the stations observed.

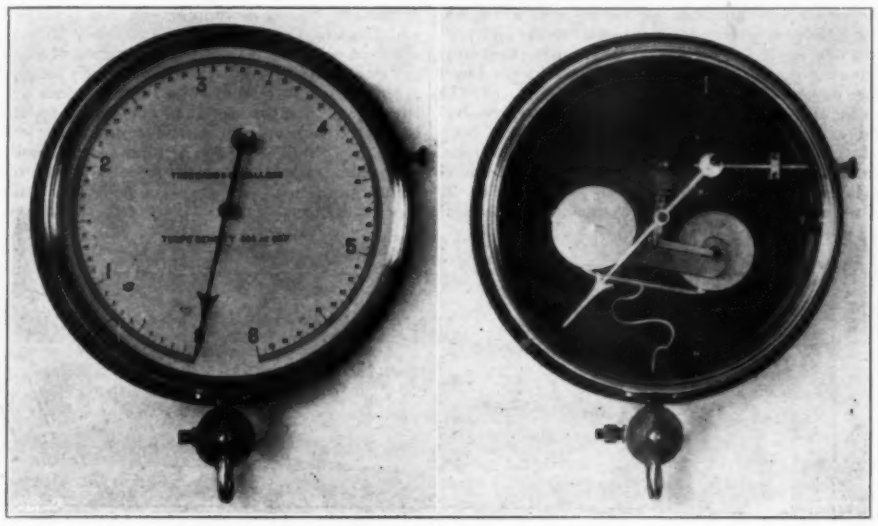
The apparatus exhibited consists of an ordinary Marconi wireless direction finder combined with an attachment which repeats the indications of a Sperry master gyro compass. The attachment comprises a repeater motor on the side of the cabinet, which motor drives a metal compass card graduated from 0 deg. to 360 deg. and capable of rotation outside the fixed "relative bearing" card. The rotatable compass card is driven through gearing from a worm at one end of the repeater motor armature spindle. The goniometer knob carries a pointer, one end of which gives the bearing of the observed station relatively to the ship's centre line, while the other end gives the true bearing, that is to say, the relative bearing plus the compass bearing of the ship's course.

In the design of the attachment, accessibility to the goniometer coils has been kept in view. Three milled thumb nuts hold the repeater motor in position, and when they are released and the motor withdrawn, the whole goniometer can be removed by taking out four screws on top of the ebonite panel.

NEGRETTI AND ZAMBRA.

Among the various exhibits of instruments and other devices of scientific interest shown by Negretti and Zambra, of 38, Holborn Viaduct, E.C. 1, is a

form of tank gauge working on the hydrostatic principle. This gauge is applicable to the measurement at a distance of the level, volume or weight of liquid in a tank, to the measurement similarly of the height of water in a reservoir or the depth of water in a river or harbour, to the measurement of the draught of ships and to other similar purposes. As explained in the description of a similar form of apparatus exhibited by another firm, and dealt with in our Supplement last week, the principle underlying the operation of the gauge consists of measuring the



FIGS. 28 AND 29—DIAL GAUGE FOR TANK LEVEL MEASUREMENTS—NEGRETTI AND ZAMBRA

pressure of air required to expel completely the liquid from a pipe inserted in the liquid and extending to the foot of the tank.

In the Negretti and Zambra arrangement the end of the pipe inside the tank is provided with a "diving bell" in which a notch is cut 1in. from the base. The level of this notch provides the datum of the gauge, the zero of which is set to indicate a depth of 1in. of liquid in the tank. The object of the diving bell is to provide a volume which is large relatively to the volume of the small bore pipe connecting the tank to the gauge on which the pressure or level is read. Any slight leakage of the liquid against the pressure of the air is in this manner rendered of little moment on the reading obtained, and as a result, the system may, it is claimed, be operated for many days consecutively without resort to the air pump. For liquids of a corrosive nature the diving bell and the connecting tubing are made of brass, lead or other metal. Should the liquid be of a very viscous nature, a length of pipe 1in. in the bore is interposed between the diving bell and the small bore connecting pipe in order to avoid any temporary blockage of the small pipe.

The usual pump is fitted for driving the liquid out of the connecting pipe and diving bell before a reading is taken. The gauge on which the pressure or level is measured is not, however, of the mercurial manometer type, against which or any similar device containing a liquid, the makers state there are several disadvantages. They point out that as the pressures to be measured are commonly those corresponding to heads of water ranging from 2ft. to 12ft., a liquid gauge has hitherto been preferred because of the difficulty of designing and constructing a dial pressure gauge of the Bourdon or barometric type capable of reading accurately pressures below 10 lb. per square inch, corresponding to a head of about 24ft. of water. Messrs. Negretti and Zambra claim to have evolved a satisfactory design of low pressure dial gauge. In contrast to a liquid gauge, such a gauge, they claim, is open in its scale, is free from errors introduced by the effect of pitching and rolling on the zero, and from those caused by a failure to set the gauge truly vertical and is easy to install and to keep clean.

In Fig. 28 we illustrate a dial gauge of 12in. aperture, calibrated to read the contents of temperature tanks, and in Fig. 29 we show the internal mechanism. The gauge contains two sets of diaphragms of a non-corrosive alloy connected in parallel with the source of pressure. The diaphragms operate on the pointer spindle through a special form of gearing designed to minimise backlash and friction. Spring-controlled levers are employed to prevent the derangement of the mechanism in the event of excess pressure being applied to the gauge. It is claimed that hysteresis errors and errors arising from vibration or the position in which the gauge is placed have been practically eliminated.

Other exhibits on Messrs. Negretti and Zambra's stand include various forms of thermometers and hygroscopes, draught gauges and automatic temperature control apparatus. Among the exhibits of the thermometer class considerable interest attaches to the form of dial thermometer which the firm has recently developed. This instrument—illustrated in Fig. 30—is designed to replace the familiar mercury-in-glass type of thermometer, over which it is claimed to possess important advantages. It can, it is said, be more accurately and easily read than a liquid column in a glass tube, is more robust, can be fitted in any position up to 150ft. away from the bulb, can be fixed on a centralised instrument board, and can be fitted with a recording attachment. In the development of the instrument many difficulties had to be overcome. The thermometric substance used is mercury enclosed in a steel bulb and a steel capillary tube. Some method had to be found for compensating the effect of changes of temperature in the capillary tube, for the possible errors from that cause may be very great. The method of compensation adopted consists of running an inner wire down the centre of the tube, the proportions being such that the amount of mercury in the tube under all conditions of temperature bears the same proportion to the size of the tube as the expansion of mercury does to the expansion of steel.

The choice of mercury as the thermometric sub-

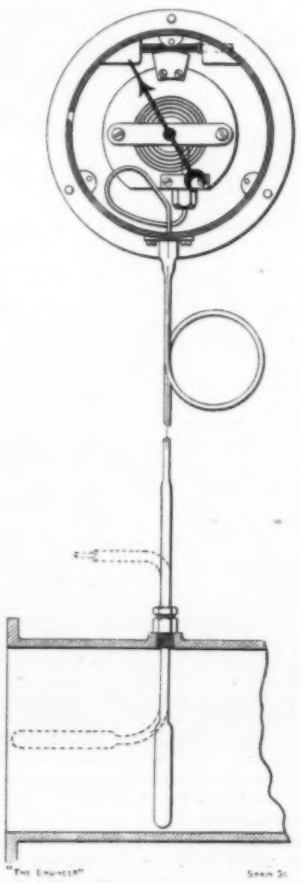


FIG. 30—DIAL THERMOMETER—NEGRETTI AND ZAMBRA

stance was dictated by the facts that it exists in the fluid state over a wide range of temperature, expands uniformly and assumes the temperature of its surroundings quickly. Its employment, however, in conjunction with steel made it necessary to discover some method of treating the steel to prevent amalgamation, and with the same object to devise some alternative to brazing as a means of making the joints in the mercury containing system. We are unaware of the method adopted to prevent the steel amalgamating, but we gather that it is effective. The joints are made by welding and are stated to be non-porous under a high pressure of mercury. The pressure produced by the expansion of the mercury is transmitted to a flattened Bourdon tube made of tempered steel. The moving end of this tube is connected directly with the pointer without the intervention of gearing, levers or hairsprings, all of which may be sources of friction and backlash.

Errors arising from changes of barometric pressure, a cause of trouble in distance thermometers of the vapour pressure type, have, it is claimed, been eliminated by the use of mercury as the operative medium, and by adopting a process of filling the system under pressure. Another difficulty that had to be surmounted consisted of eliminating changes in the zero produced by the pressure of air in the system. The special apparatus installed for this purpose would appear to be very successful, for, according to a National Physical Laboratory test, the zero change did not exceed 1/10th deg. Cent. during five years.

E. T. White and Co., Ltd.

The firm of E. T. White and Co., of Clare House, Kingsway, London, W.C., is showing an interesting range of motor component parts. They comprise a series of machined cast iron parts, such as cylinders, crank cases, gear-boxes, pistons and bearings, some of which are made from close-grained cylinder iron and others from Perlit iron, both materials being cast in the foundries of Henry Watson and Co., Ltd., of Newcastle, for whom Messrs. White act as London agents. With a view to showing the comparative impact-resisting qualities of Perlit and ordinary cast iron, a testing machine is seen in operation on the stand. Other parts displayed include a series of phosphor bronze bearings and bushes, and die-cast

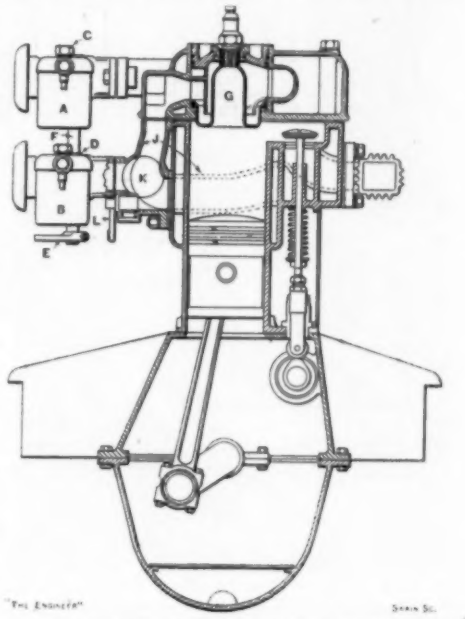


FIG. 31—"VAPOUR OIL SYSTEM" OF FUEL SUPPLY—WHITE

bearings in various forms, as well as crank shafts, axle shafts, gears, &c. Among the complete engines shown are two White four-cylinder engines of 75 mm. bore by 130 mm. stroke and 4in. bore by 5in. stroke, designed for R.A.C. ratings of 13·5 and 25 respectively. Alongside these engines is a Watson engine with a bore of 115 mm. and a stroke of 140 mm., with an R.A.C. rating of 40. Examples of the Warmoto car heater are also shown. An exhibit on this stand which will no doubt attract some attention is the "Vapour oil system," for enabling petrol engines to utilise heavy fuel oils. We illustrate this device by Fig. 31, and we may state that Messrs. White have obtained the manufacturing rights for the system from the British Continental Association, 2 and 3, Duke-street, St. James, London, S.W., which firm holds the world patents. The system has largely been developed in Italy, where, we understand, considerable success has been obtained. Satisfactory tests have also been carried out on British motor lorries. The device consists essentially of two separate carburetters, one for petrol and one for heavy oil, with the necessary interconnecting controls and heating passages for gasifying the heavy oil and forming an easily combustible vapour. It can be fitted to existing cars or embodied in new designs. Referring to Fig. 31, it will be seen that there is an upper carburetter A and a lower carburetter B respectively. The carburetter controls C and D are joined together by a short shaft F, which is provided at its lower end with a lock E connected to the dashboard hand and pedal controls. When starting from cold the engine runs on petrol alone, and by setting the rotary valve K the lower carburetter B is alone in operation. After the engine has warmed up so that the cooling water in the cylinder head reaches a temperature of, say, 100 deg. to 125 deg. Fah., the rotary valve K is reversed, and the extra air inlet L opened. By means of

this arrangement the carburetter B is shut off and the collector tube J is opened to the engine intake, thereby bringing the carburetter A into service. The induction now set up draws over a mixture of air and pulverised heavy oil, which passes along the heating chambers A and around the inner surface of the bell-shaped gasifier G, which is in direct contact with the hot cylinder gases. By this means a combustible vapour oil is formed to which extra air is added in the collecting tube J, after which it passes to the engine cylinder and is fired in the ordinary way. Heavy oils containing a small amount of paraffin wax may be employed and a range of specific gravity of from 0·880 to 0·890 is recommended. The system we have described is claimed to be of particular advantage abroad where supplies of heavy fuel are available. The cost of converting an existing motor engine is, we learn, comparatively small.

The British Perlit Iron Company, Ltd.

The British Perlit Iron Company, Ltd., of 15, Victoria-street, was recently formed to develop in Great Britain the patented process for the production of Perlit iron castings, invented and worked in the foundries of Heinrich Lanz, of Mannheim. By subjecting the metal to careful metallurgical control as regards its composition and by pre-heating the mould and core so that the rate of cooling of the casting is correlated with the thickness and the mass of the casting, it has been found possible to produce a pearlitic structure throughout all sections. The casting thereby produced is also tough and malleable and shows a marked difference in fracture as compared with that of ordinary cast iron. In Figs. 34 and 35 two fractures of 5¼in. diameter castings are reproduced to the same scale showing the fine grain of the Perlit iron. The grey iron so produced is remarkably low in its silver content, and is therefore largely immune from growth when exposed to high temperatures, which gives Perlit iron a particular importance for marine oil engine work. A considerable amount of development work in connection with the production of standard castings of Perlit iron has been carried out at the foundries of the North-Eastern Marine Engineering Company, Ltd., Wallsend-on-Tyne, under the superintendence of Mr. H. Young. In this connection it is of interest to learn that Mr. Young has now been appointed the consulting metallurgist of the British Perlit Iron Company, Ltd. Several examples of North-Eastern-Perlit castings are exhibited at Olympia on that company's stand, and the two we have chosen for illustration are a piston with white metal lining for the high-compression stage of a marine oil engine which, when cast, had a weight of about 4½ cwt.—see Fig. 33—and a large marine oil engine piston of about 30 cwt.—see Fig. 36.

The consistent qualities of Perlit iron are such, we are informed, as to render it to all intents and purposes a new metal. It is claimed that, for the first time in British ironfounding, a cast metal can be produced which possesses properties which permit of the strength and weight of any casting being predetermined with an accuracy which up to now has been associated with mild steel constructional work alone. In order to illustrate the consistent values obtained when testing a Perlit casting we reproduce in Fig. 32 some results recently obtained in the testing laboratory of a British university on a liner designed for an oil engine. The equality of the results obtained from tensile, transverse, hardness and impact tests is certainly very marked. Results can be checked at Olympia, as both hardness and impact tests can be made on the stand. The characteristics which we have briefly outlined have enabled certain licensees, both in Great Britain and on the Continent, to reduce considerably the scantlings of their castings without any sacrifice in strength. Thus we learn that the North-Eastern Marine Engineering Company, Ltd., has been enabled by the use of Perlit iron to reduce the sizes of many of its marine oil engine parts by 10 per cent. Equally interesting is the information that Alfred Holt and Co., of Liverpool, have cut down their specification weight for bollards, hawse pipes, &c., made in Perlit iron by about 15 per cent. On the Continent Messrs. Bohne and Herbe, of Wurzburg, manufacturers of printing machinery, found it possible, after six months' experience with Perlit castings, to reduce the weight of their machines by 15 per cent., and they have since been able to make further reductions in weight. A very comprehensive display of Perlit iron castings made from various branches of the engineering industry on the Continent was recently made at the Foundry Exhibition which was held in Düsseldorf. By arrangement with the various firms who then exhibited castings it has been possible for the British Perlit Iron Company to show at Olympia some of the more interesting specimens of continental work.

An outstanding exhibit consists of two headers for economiser tubes made by Steinmuller in Germany. One is cast in ordinary grey iron, such as is normally used for that class of work, and the other in Perlit iron. These castings are suspended in such a manner that when struck with a hammer a sound test can be made. The difference in "ring" between the cast iron and Perlit iron headers is very noticeable, the ring of the latter casting being more pronounced and not unlike that usually associated with steel. Other castings of undoubted interest comprise parts of agricultural tractors, gear wheels and pinions, fire-bars and chain-grate components, motor cycle cylinders, liners and pistons for marine oil engines, and parts of papermaking machinery and chemical apparatus. The display would certainly seem to show the very wide field to which Perlit iron has been successfully applied. The exhibit we refer to should help to disperse the idea that the Lanz Perlit iron process is one which is difficult to apply in any well-run modern foundry. True it is that careful laboratory work will be required if the necessary control of composition is to be maintained. The question of raising the cores and moulds to the desired temperature would not seem to present great difficulties, and for this purpose we understand that a Oehm patented heating element is recommended. In this apparatus, which is supplied by the British Drying and Heating Company, Ltd., of Abbey House, Westminster, coke fuel is used, and by means of a combined pressure and velocity system very high temperatures are obtained throughout the mould spaces or within the core drying ovens. It is not to be expected that the introduction of new methods of foundry procedure will not entail a certain amount of preliminary experimental work, but the results so far obtained would seem to indicate that considerable progress in the production of Perlit iron castings has already been made and that the process will prove to be an important contribution to modern foundry practice.

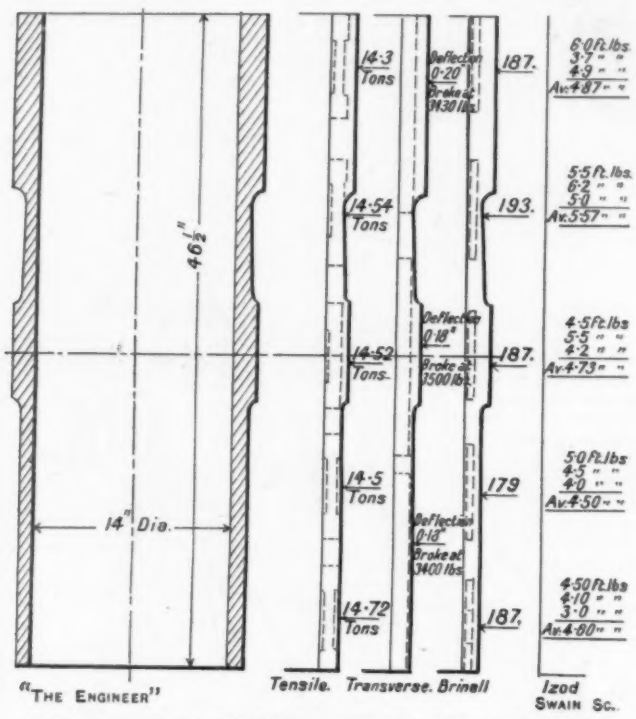


FIG. 32—RESULTS OF LABORATORY TESTS OF PERLIT IRON LINER

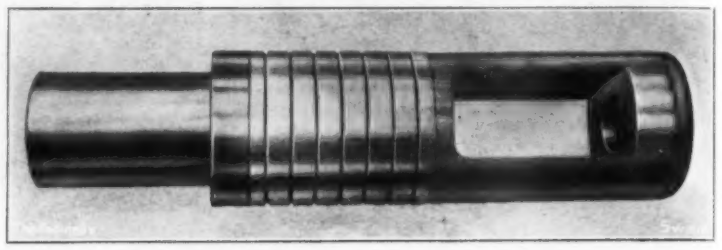


FIG. 33—PERLIT IRON AIR COMPRESSOR PISTON

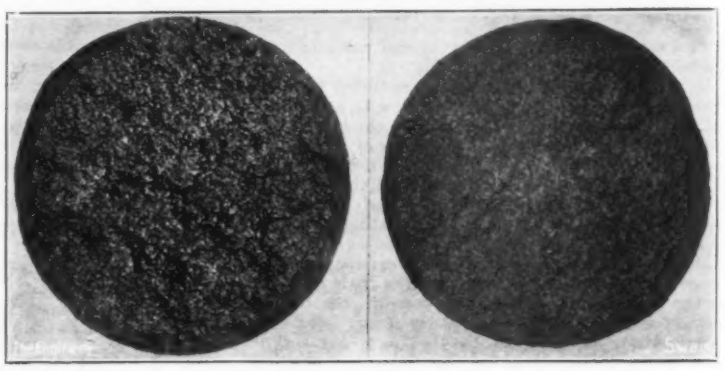


FIG. 34—ORDINARY CAST-IRON FIG. 35—PERLIT CAST IRON

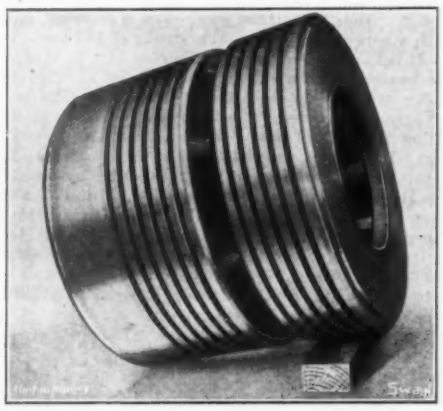


FIG. 36—PERLIT IRON PISTON FOR DIESEL ENGINE

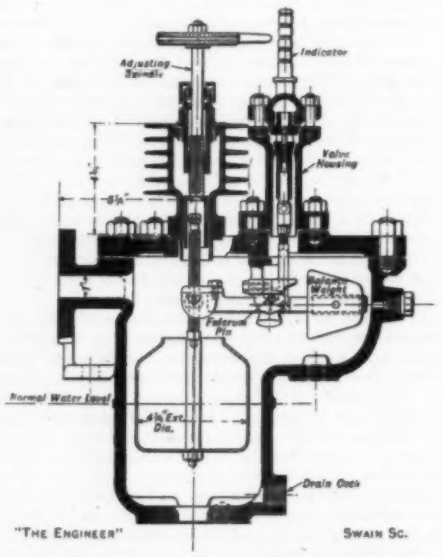


FIG. 37—FEED WATER REGULATOR—ASTER

The Aster Engineering Company, Ltd.

The continuous-action feed water regulator shown by the Aster Engineering Company, of Wembley, is generally similar to the standard "Aster Anthony" feed-water regulator which we have already described, but the new apparatus has been designed to meet conditions resulting from the use of pulverised fuel and also to give a more or less continuous feed characteristic. It consists of a control box embodying two float-operated control valves. In Fig. 37 these two control valves are arranged to lag one beh nd the other. The

float operating mechanism consists of the "Aster" standard open type float carried on a lever mounted on knife-edge bearings and arranged with the standard form of adjustment to give various heights of water level control.

The check valve, shown in Fig. 38, consists of two valves in a common box, each of these valves being capable of dealing with approximately half the total feed required by the boiler. The lift of each valve, however, is adjustable so that this proportion can be varied as required. Each of these check valves is connected by means of a ¼in. operating water pipe to one of the control valves previously mentioned, so that the whole arrangement forms two complete and distinct feed-water regulators. The action is as follows:—

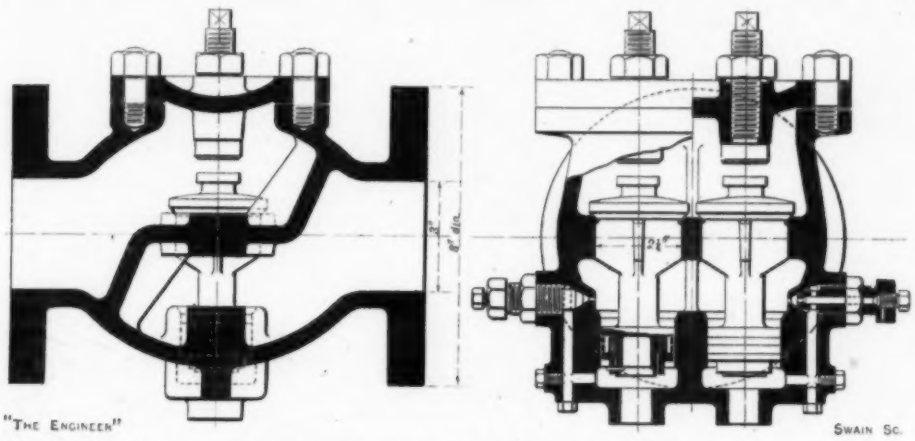


FIG. 38—DUPLEX BOILER FEED CHECK VALVE—ASTER

With a boiler carrying a normal load, one of the control valves will be continuously shut on account of the fact that it is set higher than the second valve. One check valve will therefore be continuously passing feed to the boiler, and as the amount of feed passed by this valve is insufficient to meet the demand the second valve will open and close periodically to make up the deficiency of feed, depending upon the rate of steaming of the boiler. When the boiler is on full load this second valve will be practically continuously open, but on lighter loads it will be closed for longer periods, until at approximately half load it will close and remain closed. The feed control of the boiler is then taken over by the second valve. At all loads under half-load the feed is controlled by this second small valve, and as it is proportioned to be only sufficient to pass approximately half the total feed of the boiler it will be more or less continuously open, so that the continuous feed characteristics of the apparatus are maintained.

It will be observed that the float in the control mechanism will have to fall slightly lower to operate the second valve for dealing with the maximum boiler load, so that the water level in the boiler drum is carried slightly lower on high loads than on low loads. This arrangement permits of a certain amount of thermal storage in the boiler during "easy" periods to meet sudden demands for steam, and *vice versâ*, allows the boiler to fill up slightly on the load going off, which characteristic is considered by some engineers to be most suitable for modern conditions.

The apparatus does not depend on any thermostatic principle whatever, but is operated entirely by change in water level in the boiler. The operation is therefore practically instantaneous, and the time taken for the check valve to come into action after the change in level has taken place is, we understand, less than five seconds. This feature is, of course, of particular value in the case of pulverised fuel boilers, or, in fact, in any case in which a boiler is driven hard.

FIG. 39—SHIPS' BOAT-LAUNCHING GEAR—MACLACHLAN

The Maclachlan Automatic Boat Davit Company, Limited.

The ingenious boat lowering gear which is associated with the name of the Maclachlan Automatic Boat Davit Company, Ltd., of 247, West George-street, Glasgow, is demonstrated on that firm's stand by means of a series of true-scale working models, supplemented by photographs of recent installations. The Maclachlan boat gear has been referred to in The Engineer, notably in connection with the description of the motor liner Aorangi, which was published on January 2nd, and also in the account given of the Orient liner Oronsay, in our issue of February 13th. Single 30ft. lifeboats, capable of accommodating eighty persons, were fitted on the Aorangi, and the illustrations—Figs. 39 and 40—reproduced herewith serve to show some of the boats on that vessel in the stowed and launching positions respectively. The outstanding feature of this type of boat gear is that it is gravity operated, and as the inboard stowed position of the boats—see Fig. 39—corresponds practically to the outboard stowed position of the boats with many other types of gear, there is no necessity to swing them out. It will be seen that the boats are suspended in their cradles by single-wire rope falls, which are controlled from a common winch, thereby ensuring that both ends of the boat are lowered simultaneously and a level keel is maintained. Provision is also made to keep the boats automatically alongside and in close proximity to the embarkation deck no matter what degree of list is on the vessel at the time the boats are launched. By releasing a safety catch and lifting the winch brake the cradle with the suspended boat moves under gravity over the trackways and down the side of the ship until the out-turned cradles come to rest on stopper pins. When the passengers have embarked the boat can be lowered into the water by means of the brake on the winch. Where two nested boats are employed, as on the Orient liner Oronsay, the two boats are transported over the side of the ship together, the outer and larger capacity boat being lowered to the water first, whilst the smaller boat remains suspended below the davit heads by two wire rope pennants. Such an arrangement has the undoubted advantage that approximately two-thirds of the ship's complement are got away in the first boats launched. When a boat has been launched the falls are easily and quickly recovered by hand power on the winches. On the other hand, where the larger class of lifeboat or nested boats are to be handled electrically operated boat-hoisting winches are fitted. These are not essential, however, for small lifeboats, as the hand winches are very easily operated.

The apparatus also has important constructional advantages. The trackways down which the cradles and the lifeboats move over the ship's side—see Fig. 40—are built into the ship's structure and so form effective deck side supports. It is claimed that Maclachlan davits require fewer boat deck supports, and that deck stresses are reduced. Should awnings be required on the boat deck they can be attached conveniently to the top ends of the trackways.

Furthermore, the stowage is very compact, as the davits are contained well within the boat's length, and the bottom of the boat is 6ft. to 7ft. above the deck surface. The saving in fore-and-aft deck space permits of more launching stations in a given length of ship's side than is possible with some other types of gear, whilst clear headroom gives more free space under the lifeboats, as the side rail of the ship may be carried out almost to the curtain plate. Such space is also valuable for the mast and the funnel shrouds, which can be carried right under the lifeboats and do not obstruct promenading space.

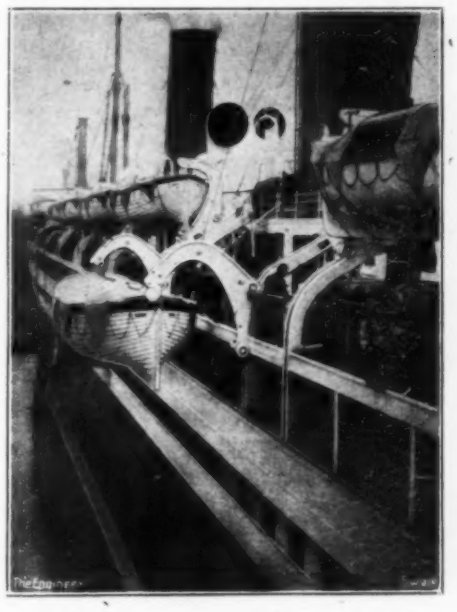


FIG. 40—MACLACHLAN BOAT-LAUNCHING GEAR

Ironmaking in the Forest of Dean.*

By RHYS JENKINS.

The coalfield of the Forest of Dean is irregular in outline, roughly it may be said to be oval, with its greatest width between Cinderford and Stanton, about 8 miles, and its greatest length from Howle Hill, in the north, to Lydney Park, in the south, say, 12 miles. The coal measures rest on the Drybrook sandstone and the carboniferous limestone. The outcrop of these rocks forms a strip extending nearly all round the coal basin, and it is in this strip that the iron occurs. The ore is a brown hematite and varies a good deal in quality; some raised in 1917 and sorted by hand showed for the lumps—about one-tenth of the bulk—58 per cent. of metallic iron; the remaining nine-tenths had about 45 per cent.

The rich pure ore of the forest, for we may safely assume that only the best was used, was admirably adapted for reduction by the direct process, which was in use before the coming of the blast-furnace. That process, however, was a very wasteful one, for a considerable percentage of the iron in the ore was not reduced, but remained in the cinder, of which

* Newcomen Society, November 18th, 1925.—Before reading this paper Mr. Rhys Jenkins expressed his indebtedness to "Ironmaking in the Forest of Dean," by Rev. H. G. Nicholls. London: C. A. Bartlett. 1866.

there were at one time considerable deposits in and around the forest. It was remarked in the eighteenth century that the quality of the cinders, while fairly uniform in any particular bed or deposit, varied very much from one bed to another, some showing a material very rich in iron, others a much smaller proportion of the metal. No doubt this variation corresponds to a less or greater skill in conducting the smelting operation and possibly to variation in the efficiency of the apparatus employed. Whether the deposits richer in iron were the earlier, we cannot say; but it is not unreasonable to think that with the passage of time improvement did occur both in the apparatus and in the skill of the workman. There is some indication, too, that towards the end of what we may call the "bloomary" period, the old cinder was being re-worked in the forges.

These cinder deposits no longer exist, or if they do, they remain to be discovered, but they did form a striking indication of the antiquity of the Forest of Dean iron industry. Two hundred years ago the deposits, some visible, others buried under several feet of soil, were of vast extent, and must have amounted to thousands of tons. For nearly 200 years cinder was smelted with the ore in the blast-furnaces of the district, the charge being half cinder and half ore. A good deal was sent away, some of it by sea—as early as 1601 we find a patent granted for exporting it to Ireland, to be used for ironmaking. The apparent supplies appear to have been approaching exhaustion at the beginning of the nineteenth century, but even to-day cinder deposits are discovered. Within the last month or so, as I am informed by our member, Mr. Thomas Newcomen, of Coleford, a cinder bed was cut into in digging a trench in the main street of that town, and earlier in the year a quantity of cinder from a deposit in private grounds was sold to ironworks in South Wales.

When we consider the limited output of each forge, and bear in mind that, at any rate in historic times, the number at work was not very great—the maximum was about seventy in the thirteenth century—it is evident that this large accumulation of cinders must have been the work of a long period of time. The discovery of Roman coins embedded in the cinders takes us back to the beginning of the Christian era, and it seems to the writer that when the Romans came they found the industry in existence, but no doubt it was developed considerably in their time. Between the end of the Roman occupation and the beginning of the twelfth century we have nothing to show what was going on, but it is very unlikely that the industry died out, for iron was always in demand.

From the twelfth century onwards we have documentary evidence, and there seems to be no question that during the twelfth, thirteenth and fourteenth centuries the Forest of Dean was the most important iron-producing district in this country.

In spite of a profusion of evidence of the existence of the industry, we have little or nothing on the technical side. However, going outside the district, we have an account which we may conclude represents substantially the practice followed in the forest in the sixteenth century. In 1531 a forge that was being worked for the King (Henry VIII.) in Glamorgan the men were forest men and the ore was hematite like that of the forest. The account tells us that: "There are five men who keep the fire to melt the ore, having 12d a day each after the manner of the said Forest of Dean. And there are four men at the Byllos whereof 3 blows at a time and one of them stoude voyde to refreshe the others for he bloweth 6 or 7 hours atte evere gadde that is melting, and thus they make 2 gaddes a daie each weighing 1 cwt. Each blower receives 7½d a day and 12d is paid to the fewar."

The iron was sent off in the form of these gads or lumps of 1 cwt.; 21 cwt. had already been sent to Bristol. There were two gads still remaining, and there was above ground 20 cwt. of iron ore, of which every 3 cwt. should make a gad of 1 cwt. or more. Three men were employed in the iron mine—one of whom "hews the mine, another hews timber to stay it, and another bears the ore uppe, who brings up in a day 1000 weight. Of these three men, the one who digs the mine has 12d a day after the rate of the Forest of Dean; the one that shores it 6d per day, and the third who bears the ore up 6d per day. Three collyers are also engaged at 6d a day."

It will be seen that production was on quite a small scale; it took nine men working twelve to fourteen hours a day to make 2 cwt. of iron. Most probably the forges scattered about the forest were worked by fewer men and produced even less.

With the introduction of the blast-furnace a great change took place, and we now begin to speak of production in tons, in stead of in pounds and hundredweights. The blast-furnace was in use in Sussex before the year 1500; it was to be found in Glamorgan and Monmouth in the course of the sixteenth century, but it was not until the beginning of the seventeenth century that it made its appearance in the Forest of Dean. All the available evidence goes to show that the first furnaces were put up by William Herbert, Earl of Pembroke in the year 1612, or between that and the year 1614. The Earl was not the first to come forward with a project for erecting furnaces in the Forest, for in the year 1611 (June 14th) an agreement had been made with Giles Bridges and others, whereby they were given "liberty to erect all manner of works, iron or other, by land or water, excepting wyer works, and the same to pull down, remove and alter at pleasure," also "liberty to take myne oare and synders, either to be used for all the workes or otherwise . . . and the like for sea cole and marle." On the other hand, they were to pay 3s. a cord for 22,000 cords of wood annually and 8s. a ton for 1500 tons of timber.

This agreement was for ten years, but within a few months it was superseded by the grant made to the Earl of Pembroke, and there is nothing to show that Giles Bridges had set to work in the meantime.

The Earl of Pembroke was a man of great power and influence, and he was considerably interested in the Forest of Dean. In 1608 he succeeded Sir Edward Winter in the "office of Constable of the Castle of St. Briavels in the Forest of Dean, with the keeping of the deer and woods there," and in 1611 the manor, town, and Castle of St. Briavels, and the Forest of Dean were granted to him at a yearly rent for forty years. He was governor of the corporation of the Mineral and Battery Works, a company that was drawing iron wire by power at Tintern under the patent granted to Humfry and Shutz in 1565.

The grant made to the Earl gave him power "to erect so many iron mills, furnaces, forges and bloomeries for the making and working of iron, and so many other new works of what kind and manner so ever by land or water (wire works only excepted) within the precincts of the said forest, and to repair, pull down, remove or alter the same at his will and pleasure." The grant included the right to "all water and watercourses which are within the precincts of the said forest, free and without stoppage," and power to "make so many stancks, ponds, pondheads, wastes watercourses, trenches, floodgates and passages for water in any part of the said forest as he shall think fit." Liberty was "given to take timber for the building, erecting and repairing the said ironworks, coal houses, store houses, houses for workmen, or other buildings, ponds, trenches, floodgates, &c." The Earl was also empowered to enclose up to 12 acres of ground for each ironworks, and to take up to 12,000 cords of wood per year at the rate of 4s. a cord. It seems, too, that he was to have 12,000 cords annually without charge. This agreement, although made for a term of twenty-one years, lasted but for three. The Earl or his agents came into conflict with the people of the forest, and there was some amount of rioting. In particular grants made to him in respect of the mines clashed with the rights claimed by the miners, who persisted in carrying on their trade as they had been accustomed to. Pembroke lodged a complaint, and in 1613 an order was made allowing the miners out of charity and grace, and not of right, to dig for mine ore and cinders to be carried to his Majesty's ironworks, and not to any other place, at the accustomed rates. This was a temporary order until the cause of the miners should be heard and determined. We hear nothing more of this matter, so it would seem that the miners were able to make out a good case. Soon after this the Earl gave up his grant and the works he had built were leased to Sir Basil Brooke. The agreement with Brooke is dated May 3rd, 1615, and its terms make it quite clear that by that date ironworks had been erected. We read: "The workes already built only granted, with no power to remove them, but bound to mainteyne and leave them in good case, and repayre, with all stock of hammers, anvills, and otherwise received at the Pattenties entry. Liberty for mine and synders for supply of the works onlye, without selling of any, to be taken by delivery of the miners at the price agreed upon, wherein also the farmers to be ordered by the Exchequer from time to time. No power to medle with seacole or marle."

Brooke was allowed 12,000 cords of wood per year, and he was to pay for it in iron—320 tons a year. The cord wood was to be used for the ironworks only, and "no manner of timber trees of oak to be cut for corde wood, neither any trees beech or oak before the officers have marked what trees shall stand. — — — no tree marked to be felled upon forfeyture of 10s for every tree, or double the value, att his Mtys. pleasure."

Brooke held the works for about five years, and from this time on to the outbreak of the Civil War there were a number of changes in the ownership. In 1621 the works were leased to Challoner and Harris, in 1627 to the Earl of Pembroke, who sublet to Brooke and others; in 1636 to Throckmorton and others, and in 1640 Sir John Winter was in possession. It seems that in each case the grant was cut short owing to allegations that the farmers were taking more wood than they were entitled to. The question cannot be dealt with in this paper, but a little story that comes out in one of the inquisitions may be given. This inquisition was made at Coleford in 1626 and one of the witnesses deposes "that he knows that one Henry Rudge, a woodward in the said forest did receive a two and twentie shilling peece in coyne in goulde for a reward in conyvinge at the delivery of wood to the said farmers or their servants, and half a ton of iron at another time, by reason whereof his Majtie hath bene exceedinglie abused, for the said Rudge told this deponent that they (the farmers) had reason to give bribes to the woodward, for he did help them to as much wood in one day, as was worth thirty pounds at the King's rate."

The inquisition just quoted gives us the first list we have of the King's furnaces and forges. There were four furnaces; one "at the park of West Meade," one at Soudley, one at Lydbrook, and one at Cannop. At Park there was one forge with two hammers "for refining iron," at Soudley there was one forge, and at Lydbrook there were two, but one of them is said to be "none of the King's works, but the nowe farmers rent it of George Vaughan." Apparently the furnaces and forges at Park and Lydbrook were in regular use, those at Cannop and Soudley not so.

A list made eight years later, *i.e.*, in 1634, enumerates the same works on the Crown lands, and in addition it gives the earliest list we have of the works in private ownership. There were furnaces at Lydney, Gunn's Mills and Rodmore, belonging to Sir John Winter; two furnaces at Newland owned by Mr. Hall, Sir Richard Cachemay had a furnace at Brockweir, and Sir John Carne one at "Purtness Pool." This last place the writer has failed to identify. At the same time Winter had forges at Lydney, Hall at Lydbrook, also Carne, and two forges at Flaxley were owned by Mr. Typper. In all there were eleven furnaces and ten forges, making twenty-one separate works. Very soon after there were additional forges at Whitecroft and Bradley, belonging to the Crown, and a furnace at Bishopswood in private ownership. Thus about 1640 there were twelve furnaces and twelve forges in the district, probably not all at work. At what date the first of these privately-owned furnaces was erected we have no means of saying. Possibly Cachemay's furnace at Brookweir may have been as early as those of the Earl of Pembroke, for we find that the Earl had conveyed to him some part of his grant of 1612 within a week or so of its date. In 1640 the whole of the Crown property in the forest was sold to Sir John Winter; soon after began the Civil War, in the course of which the forest ironworks were destroyed, and Winter, who was an ardent Royalist, had to leave the country. His estates in the forest were granted by Parliament to Massey, but it does not appear that Massey did anything in the manufacture of iron. However, within a few years many of the works in and around the forest had been restored to working order. In 1649 there was a great outcry against the destruction of the forest—it was reported that there were twelve furnaces and forges in the forest kept going by forest wood, besides others in places adjacent—and in 1650 it was ordered by Parliament that no trees be cut down within the forest without order from the House, and that all ironworks within the forest be demolished. However, a few years later, in 1650, the Government was finding a difficulty in obtaining a sufficient supply of shot for the Navy, and Park furnace was restored and set going under the control of Major Wade, who also put the Whitecroft forge into operation. From September, 1654, to March, 1659, the works supplied the Navy with 700 tons of shot and 88 tons of wrought iron fittings. In 1656 the stock in hand was valued at £9446, but Major Wade "thought that 100 or 200 tons of iron thrown upon the market would surfeit the whole country." However, Wade, between September, 1657, and August, 1660, did manage to dispose of some 1200 tons of pig iron at prices ranging from £6 12s. to £7 5s.; about 5 tons of chimney backs and baking plates at £12, and between 300 and 400 tons of bar iron, the usual price of which was £17 10s. a ton. A good deal of the bar iron and all the backs and baking plates were sent to merchants in Bristol. The pig iron was probably sold to forge masters in various parts of the country. Yarranton, about twenty years later, states that the greater part of the forest pig iron was sent to forges in Worcestershire, Shropshire, Staffordshire, Warwickshire, and Cheshire.

At the restoration Sir John Winter regained possession of the forest, but the ironworks were reserved, and in 1662 they were leased to Francis Finch and Robert Clayton for eleven years. At the termination of their lease the whole of the materials of the King's works were sold to Paul Foley on condition that he demolished the buildings and cleared away the material within a prescribed time. In 1662 there was one furnace and one forge in working order; during their tenancy Finch and Clayton brought into operation another furnace and another forge, for the agreement for sale to Foley refers by name to "Howbrooke" furnace and Park End furnace, and to Park End forge and Whitecroft forge. (This is the only occasion on which the writer has met the name "Howbrooke," the furnace was probably at Lydbrook.)

The sixty years' story of the King's ironworks ends here, for although in 1683, and later still, proposals were made that the Government should set up and work furnaces and forges, nothing came of them.

Turning now to the furnaces in private ownership; we have seen that in 1634 they numbered seven, at the period we have now reached the number had increased substantially. In the Forest of Dean area, that is to say, the area immediately round and drawing its supply of ore from the forest, there were furnaces at St. Weonards, Whitechurch, Linton, Longhope, Flaxley, Blakeney, Lydney, Redbrook, Bishopswood, Brookweir and Tintern. Gunn's Mill furnace, mentioned in the list of 1634, was derelict, but it was rebuilt in 1683. Paul Foley seems to have worked or owned some of these furnaces; at any rate, in 1706 his son Thomas was concerned in seven furnaces besides forges. Other ironmakers at the period were Lady Winter, Mrs. Boevey, and Mr. White. After this the forest iron trade declined. In 1788 four furnaces are stated to have been at work in Gloucester-

shire, but this number probably includes Tintern and Bishopswood, which are beyond the county borders. In 1796 Flaxley and Bishopswood were at work. Flaxley furnace seems to have been idle in 1802, but it is likely that it was at work later than this, for there is at Flaxley Abbey a cast iron block, measuring 11¼in. by 5½in. by 5½in., lettered "Flaxley Works, 1812," presumably intended for a weight. Lancashire ores had been introduced about 1780 to replace the failing supply of cinders, and it is said that in some cases they were used to the exclusion of the forest ores. When the Earl of Pembroke put up his furnaces in 1612–14 they were probably as large and as well arranged as any in Sussex. The furnace at Cannop had a "bridge house" at the top, and a "furnace house," or foundry, at the bottom. There was a house for the clerk, another for the founder, a cottage for the filler, a cabin for the furnace keeper, and another for the "mine cracker." There were "myne kilns" at some of the furnaces, but it is not clear that it was the regular practice to roast the ore. The furnaces were built of a forest stone, 22ft. square and about 20ft. high, and with an internal diameter of 8ft. or 9ft. at the boshes. At a later period some furnaces were built 24ft. wide and up to 30ft. high. Probably some of the privately-owned furnaces were of smaller dimensions. For each furnace there were two bellows, about 18ft. by 4ft., and at Cannop and Park, the bellows were worked by water wheels 22ft. diameter. The make was 20 tons of pig iron per furnace per week as a maximum, and this appears to have been fairly constant throughout the whole period of the charcoal furnace.

As to the consumption of wood and charcoal seeing that we are uncertain as to the value of the units of measurement, the figures are perhaps of little value, but we read in 1626 that 2½ cords of wood "of the measure that his Majesty alloweth" will make a load of charcoal, and in 1662 the two long cords will make a load. Two loads of charcoal were required to make a ton of pig iron, and at the forge three loads of charcoal were used per ton of bar iron made. At the beginning of the nineteenth century it was stated that fifteen or sixteen sacks of charcoal were required to make a ton of pig iron.

The idea of substituting pit coal for charcoal in the furnaces and forges of the Forest of Dean must have suggested itself at an early date. In 1683 it was in use in some of the forges, and Powle states that several unsuccessful attempts had been made to bring it into use in the furnaces, "but," he goes on, "hitherto they have proved ineffectual. The workmen, finding by experience that a sea coal fire, how vehement so ever will not penetrate the most fix'd parts of the ore, and so leaveth much of the metal unmelted." Possibly one of the attempts that Powle had in mind was that of Jeremy Buck of Minchinhampton; his first trials, according to Dud Dudley, were carried on in the Forest of Dean. Buck obtained an Act of Parliament in 1651 for the protection of his invention for "Melting down iron and other metals with stone-coal and other coals without charking." Another attempt may have been made by Sir John Winter; Evelyn tells us that he was experimenting with charking coal (coke) at Greenwich in 1656, and in 1661 he applied for a patent. More than a century later, we are told by one author—Samuel Rudder: "New History of Gloucestershire," 1779—that coke had been tried at Lydney about 1773 and found not to answer. Another writer—Thomas Rudge: "History of the County of Gloucester," 1803—a few years after, however, states that much ore is reduced by coke at Lydney furnace, but, he adds, "where pit coal is used the iron is allowed to be of inferior tenacity and ductibility." The same writer, referring to the Flaxley works, says that the iron is estimated peculiarly good; but its goodness does not arise from any extraordinary qualities in the ore, but from the practice of working the forges with wood charcoal without any mixture of pit coal."

By this time the use of coke in the blast-furnace was general throughout the country, and indeed a coke furnace had been put up in the forest at Cinderford in 1795. This enterprise was not a success; it is stated that the make did not reach 20 tons a week. Even at this date the ore was brought to the furnace on mules' backs. In 1798–9 a furnace was erected at Whitecliffe, near Coleford; this again was an unsuccessful venture. David Mushet was connected with it for a few years. In 1799 a furnace was put up at Park End, and in 1827 there were two furnaces at this works, each 45ft. high, 14ft. diameter at the boshes, 5ft. at the hearth and 9½ft. at the top. To blow these furnaces a water wheel, 51ft. diameter and 6ft. wide, was erected, and ponds and leats were constructed at a great expense; the wheel, however, was speedily replaced by a steam engine. Very soon after this another commencement was made at Cinderford, and two blast-furnaces were erected. Two furnaces were put up at Soudley in 1837, and at later dates others were erected at Dark Hill and Oakwood. In 1873 there were ten furnaces in Gloucestershire, but from that date the industry declined rapidly, and in 1878 only two furnaces were at work; those were at Cinderford, and about 1890 the Cinderford works closed down. This marks the end of iron manufacture in the Forest of Dean—an industry that, as we have seen, there is good reason to think had been carried on continuously from a period earlier than the Roman occupation of Britain.

Public Works, Roads and Transport Congress.

No. II.*

In our last issue we dealt with the papers which were read on the first day of the Public Works, Roads and Transport Congress, which was held at the Royal Agricultural Hall, Islington. To-day we proceed to give précis of the papers considered subsequently.

Water Supply.

The morning session of the Congress on Friday, November 20th, was held under the auspices of the British Waterworks Association and under the chairmanship of Mr. C. G. Musgrave, the chairman of that body. The first paper taken was entitled "Advisory Regional Committees for Water Policy," and was by Dr. I. G. Gibbon, Principal Assistant Secretary, Ministry of Health, who began by explaining that two years ago he put before the British Waterworks Association some suggestions as to the need for Regional Water Committees. The gist of these suggestions were in the main as follows:—(1) That the large authorities, at any rate, should have a policy of water supply in general outline for fifty years ahead. If an authority was not prepared with a detailed programme well beforehand, there was always a danger that it would be rushed when the need came, and have to decide on and to execute works in a hurry, and that inevitably meant waste. (2) That for any areas where neighbouring authorities had a common interest, either in the source or in the supply of water, there should be appointed Regional Committees representative of the authorities in the area, big and small. Where there were common interests there should manifestly be common action; the only question should be the measure and the form of the co-operation. The object of these Committees should be to examine the situation, to ascertain the needs and to consider and to set out proposals as to how the needs could best be met.

After quoting specific cases which, he submitted, gave force to the necessity for carrying out his proposals, the author went on to say that the problem of water supplies was likely to grow more acute. Quite apart from the increase of population and growth of demand for industrial purposes, there was a significant increase in the consumption of water per head. It was manifestly essential that wise foresight should be exercised, wise foresight based on a comprehensive examination of the situation by competent men. In the long run need would determine organisation, and it became incumbent on local authorities, if they were to maintain their position, that they should adequately appreciate requirements and adopt measures sufficient for meeting them. There was ample work for the British Waterworks Association in that sphere. The problem called not only for a wide knowledge of facts and for constructive proposals based on them, but in equal measure for that temper of mind, that wide outlook of vision, which would provide the general conditions, the general willingness to co-operate for prudent solutions, which were essential if the situation were to be satisfactorily met. He did not, he added, wish for one moment to minimise the responsibility of the Ministry of Health in the matter; on the contrary, he preferred that it should be amply realised and as amply accepted. The problem, however, was not one to be solved simply by Government departments. Local water undertakers, whether local authorities or companies, were an integral part of any solution which was going to stand the test of time and of practical requirements, and there was great work for a body like the British Waterworks Association which was representative of them. It was by the close and cordial co-operation of all the bodies concerned—the Ministry of Health, the associations and the local water undertakers—that we could hope to arrive at a wise settlement of the problem, a co-operation which was fortunately already in being and, he hoped, would be still further extended.

The second paper was entitled "Regional Policy Committees," and was by Mr. M. Ratcliffe Barnett, M. Inst. C.E. The author said that he thought that no one would disagree with the following tenets:—(1) That the water resources of the country must be utilised to the best advantage, and (2) that an existing local water authority was most likely to be the best judge of its local resources and requirements. He suggested therefore (1) that it was advisable that Regional Policy Committees for the conservation of the water supply of Great Britain should be set up without further delay; (2) that a small committee of the Ministry of Health and British Waterworks Association should be appointed to draw up the clauses of the Bill necessary to procure an Act of Parliament to constitute and define the powers of such Regional Policy Committees; and (3) that the actual division of the country into areas should be carried out by an expert Commission, composed of three members appointed by the Ministry of Health and three members by the British Waterworks Association. The names of the members of such Commission of experts could be mentioned in the Act of Parliament or could be left for nomination by these two authorities.

* No. I. appeared November 20th.

The third paper, "Water Resources and Supply: A National Policy without Nationalisation," was by Mr. A. R. Atkey, the chairman of the Nottingham Corporation Water Committee, who discussed the present position and anomalies in connection with water resources and supply, and then went on to review, in turn, (*a*) recent developments in connection with water supplies and their demands upon local water undertakers; (*b*) the difficulties of the latter; (*c*) legislation and the relationship of the State to water authorities; (*d*) the demand for national control and nationalisation; (*e*) the demand for freedom, relief from Government interference, and the growth of bureaucracy; and (*f*) the need for a national policy and how it could be obtained without nationalisation.

The first portion of the afternoon session, which was also under the chairmanship of Mr. Musgrave, was devoted to a paper on "The Extended Use of Rivers for Supply of Domestic Water," by Sir Alexander Houston, who, as our readers are well aware, is Director of Water Examination, Metropolitan Water Board. Sir Alexander began by saying that, if we excepted springs and wells, all our water supplies were derived from rivers or from the natural or artificial impounding in lakes or reservoirs of small rivulets, streams or brooks. It is not of the latter, however, that it was most desirable to speak, but rather of those rivers which were nearing the sea, which were of considerable volume and which had received the drainage from manured land and the more or less purified effluents from sewage works. The potential value of such rivers for waterworks purposes was considerable, because their volume might be so great that it was unnecessary to construct enormous storage reservoirs to guard against drought. It was an axiom that the nearer we went to the source of a water supply, the less was the risk of pollution likely to be, but the greater, unfortunately, was the necessity for building huge reservoirs. Conversely, the nearer we got to the sea, the greater was the danger from contaminations, but the less was it necessary to construct large reservoirs to cover periods of drought.

If we excepted London and a few other places, the tendency had been for large towns to fight for the possession of far distant gathering grounds for water-impounding purposes, irrespective too often of the needs of smaller communities, their neighbours or the country as a whole. This rush for the uplands had a good origin; it arose from the wise belief that it was better to drink a water which required no purification than a water which had been purified by artificial means to a high standard of perfection.

Several things had happened within comparatively recent years to alter the outlook. One was that there were but few upland and virgin sources of supply still available, in a practical sense, for waterworks purposes. Another was that science had made enormous progress, and that it was now known that it is feasible to purify impure water economically to almost any pitch of perfection desired. He hoped that he would not be thought of as prophesying smooth things and glossing over questions of safety. It was logical to remain an advocate of pure sources of supply, and yet be convinced that when they were not economically available it was quite practicable to fall back upon impure water and purify it to the highest standard of epidemiological safety. Within recent years there had been some remarkable "happenings" in the water world. Doubtless they pertained to the war or its aftermath, but they were, nevertheless, signs of the times. More than one condemned and abandoned source of supply had been purified and brought into re-use. A pure water, utterly wasted for compensation purposes, had been utilised for domestic use, and a most impure water, after suitable purification, substituted for it by "back-pumping" operations. More than one Water Bill had recently received parliamentary approval owing to the logic of facts, and the convincing evidence afforded that it was practicable to purify impure sources of supply to the highest possible standard of safety.

It needed to be remembered that the interpretation of results—chemical, bacteriological, and perhaps epidemiological—had altered greatly within recent years, and that the values of storage, the excess lime method of sterilisation and chlorination were now universally recognised. It really amounted to this—we were now prepared to condone certain imperfections provided other and more important requirements were thoroughly fulfilled. Further, we had improved our methods of purification to a point previously undreamt of. Practically, that meant that the extended use of impure waters, including rivers—subject, of course, to adequate purification processes being adopted—for domestic use was almost a certainty. The matter was really pressing, because although a great deal could be done in the way of waste prevention, the tendency was for the consumption of water to increase, owing to the changed habits of the people and the increased use of water for baths, lavatories, &c., and generally for washing and flushing operations.

There were, said Sir Alexander, two main ways of

extending the use of rivers water. The first was by diminishing the pollutions. That, unfortunately, was a very thorny subject. When the Royal Commission on Sewage Disposal visited, a good many years ago, some of the great industrial centres in the West Riding of Yorkshire, the Mayor of one of the towns visited said to the Commissioners: "Gentlemen, we want trade, not trout." That remark impressed, as well as amused, the members of the Commission, and if their reports were searched and their recommendations studied, it would be found that the Commissioners never lost sight for a moment of the interests of trade.

At the same time, it had been found in many cases that purification works might enable manufacturers to save valuable products which otherwise would be lost, and the avenues for further research in this direction were wide and numerous. Further, as our knowledge of sewage purification processes extended, it might be possible to secure purer and safer effluents at less cost than was now possible. It needed to be remembered that by diminishing the pollutions we not only made more rivers available for waterworks purposes, but opened up prospects of sport and vistas of delight for fishermen and lovers of nature. Personally, he felt very strongly that large sums of money might be usefully expended on the continued investigation of the problems, and he entirely dissociated himself from the view that our knowledge had reached a stage where further advance was impossible or improbable.

The other chief way of extending the use of rivers was the ability to show that impure waters could be so purified as to render them fit for human consumption. This was the aspect of the problem concerning which his ignorance was least. About 80 per cent. of the water supplied to the London consumers, nearly seven million in number, came from rivers not free from the charge of pollution. If impure or doubtful waters could not be adequately purified, why was it that London had such an excellent record as regards freedom from water-borne disease?

Fig. 1 showed the decline of typhoid fever in London since 1900. It was not suggested that improvements

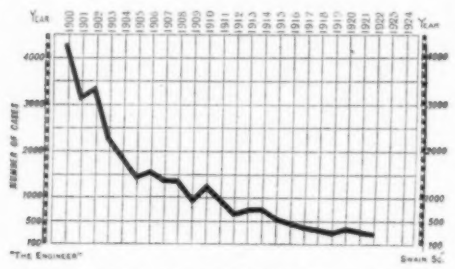


FIG. 1—DECLINE OF TYPHOID FEVER IN LONDON

in water supply were solely responsible for that satisfactory state of affairs. It might, however, be claimed that if the water supply were a real source of danger you would not expect to find a curve so flattering in character. Moreover, there had been many wholly impartial Commissions and Committees which had sat and considered that very question of the safety of London's water supply, and all knew what the verdict had been. Nor could we doubt what the result would be if a fresh Commission were called upon to review the present position. Take the conservative figure of five million London consumers supplied with highly purified, but initially impure river water, without any apparent danger to health, and contrast it with the total population of England in 1921 of roughly 36 millions, including the five millions already referred to. In other words, one-seventh of the total inhabitants of England had been and were drinking river water highly purified, but, as some thought, of questionable origin. The proportion, of course, was really higher than one-seventh, as a number of towns besides London derived their water supplies from rivers.

If it were permissible to draw a favourable verdict as regarded London, why should the use of river water not be extended, provided, at all events, that the rivers were no worse than the Thames, Lea and New River, and that the methods of purification were as good as those practised by the Metropolitan Water Board? One might go even further than that tentatively, and suggest that worse waters might be utilised safely if the methods of treatment were correspondingly improved. It needed to be remembered that in London they thought, rightly or wrongly, that they were not only providing consumers with a safe water, but one possessing a wide margin of safety.

Sir Alexander then referred to tables printed in the paper showing the percentages of purification effected in the water supplied in the London area. One table showed the difference between the raw Thames and Thames-derived filtered waters. Without going into all the figures, it may be said that 84·7 per cent. of the samples of raw water contained *B. coli* in 1 c.c. In the case of the filtered waters, 82·5 per cent. of the samples contained no *B. coli* even in 100 c.c. In the case of the Lea the comparable figures were 77·7 and 70·5 respectively, and as regarded the New River they were 46·7 and 79·0 respectively. The colour of the raw Thames was 76 as compared with only 23 in the Thames-derived filtered waters. In the case of the Lea the comparable figures were 84 and 25 respectively, and of the New River 51 and 17 respectively. There would be general agreement when it was said that these results were most gratifying. What the Metropolitan Water Board was really doing for London was to take raw water containing, say, 1000 *B. coli* per 100 c.c. and supplying the consumers with filtered water containing, say, 1 *B. coli* per 100. The results are really rather better than that, because a majority of filtered water samples contained no *B. coli* per 100 c.c. of water. That was equivalent to saying that there was less than 1 gallon of sewage, or its bacteriological analogue, in 10 million gallons of water. These results were obtained at a very reasonable cost, despite the fact that most of London's water had to be pumped twice.

It had been proved that impure water could be purified to a high standard. Considering in the first place the New River, its flow was a variable mixture of Upper Lea river water of questionable purity and pure well water. During the non-flood months of the year the results were so good that filtration alone was considered a sufficient protection. In flood time there was a marked change owing to deficient storage accommodation, and within recent years chlorination had been carried out during those periods with great success. The average dose was 1 in 2·83 millions, or 2·53 lb. of chlorine per million gallons of water. Permanganate was usually used—about 2 lb. per m.g. —as well, as a taste preventer. The net result was that the deterioration due to the winter floods was "wiped out," and that at a cost of less than 2s. per million gallons of water treated. For the year ended March 31st, 1925, the average number of first-class samples—*i.e.*, no typical *B. coli* in 100 c.c.—of New River filtered water was 83·8. The New River supply would suffice for the supply separately of such large towns as Liverpool or Manchester, at the rate of consumption of, say, 35 gallons per head per day.

Next, taking the whole of the Lea and that portion of the Thames supply which was not chlorinated —Southwark and Vauxhall, Chelsea and Lambeth water. The total volume of water involved would, at 35 gallons a head, suffice for the supply conjointly of the following towns:—Sheffield, Bristol, Birmingham, Blackburn, Huddersfield, Sunderland, Newcastle, Nottingham and Hull. Here reliance was placed wholly upon adequate storage followed by sand filtration at the slow rate of about 2 gallons per square foot per hour. The storage, if pooled, would amount to forty-six days. For the year ended March 31st, 1925, the percentage number of first-class samples—*i.e.*, no *B. coli* in 100 c.c.—was:—East London (Lea) filtered water, 74·7; Southwark and Vauxhall filtered water, 80·3; Chelsea filtered water, 90·3; Lambeth filtered water, 76·4.

What storage alone could do might be shown by the

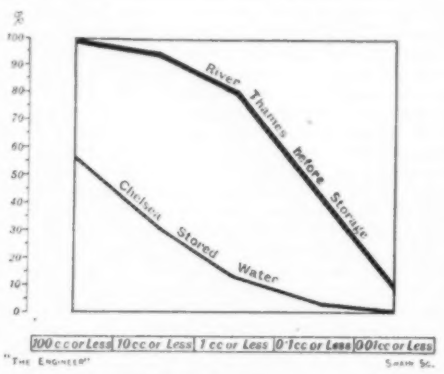


FIG. 2—PURIFICATION EFFECTED BY STORAGE

case of Chelsea. The reductions in the number of bacteria were from 4465 to 208 (gelatine), from 280 to 44 (agar), and from 41 to 5 (bile-salt agar), all per cubic centimetre. Fig. 2 showed the decline in the number of *B. coli*.

As regarded chemical results, the percentage reductions were:—Ammoniacal nitrogen, 63·4; albuminoid nitrogen, 29·4; permanganate, 27·8; turbidity, 84·9; colour, 45·8. The only disadvantage of storage was that sometimes you got an over-development of growths, harmless in themselves, but apt to cause difficulties in filtration, and occasionally to produce taste troubles.

Turning then to the rest of the Thames supply which was chlorinated—Kempton Park, Sunbury, Grand Junction and West Middlesex works—the water, amounting to 70–80 million gallons a day, was stored and filtered as well, although at some of the works concerned the storage was short. In the aggregate it amounted to about ten days, with an additional reserve of forty-four days in the Staines reservoirs. For the year ended March 31st, 1925, the percentage number of first-class samples—*i.e.*, no *B. coli* in 100 c.c.—yielded by the works concerned, was:—Kempton Park, 92·8; East London (Sunbury), 84·8; Grand Junction, 81·7; West Middlesex, 81·4. The volume of water at 35 gallons per head would suffice for the supply conjointly of such large towns as Glasgow, Edinburgh, Dublin and Belfast. The chlorination of that half of the total Thames supply was largely an economical consideration, and it had been calculated that during the last nine years over £130,000 had been saved in pumping charges. It should perhaps be explained that when the Thames was in high flood chlorination was temporarily discontinued, and Staines stored water used instead.

Sir Alexander then went on to discuss various questions relating to the extended use of rivers and the excess lime method of purification and sterilisation, and then summed up his conclusions as follows:

In support of the extended use for waterworks purposes, after adequte purification, of questionable or impure sources of supply, the following pleas might be advanced:—

(1) The interpretation of the results of the chemical and bacteriological examination of waters had radically changed within recent years.

(2) Great progress had been made in the methods of rendering impure waters apparently safe to drink.

(3) We had ceased to be obsessed by purely sentimental considerations.

(4) Our administrators were more alive to the advances in science, and less inclined to be bound down by past traditions.

(5) Over one-seventh of the population of England had been, and were, drinking with impunity, highly purified water derived from sources of questionable origin. This might be described as a physiological, or pathological, experiment on a vast scale.

(6) If the absence of *B. coli* from a water was to be taken as implying the absence of the microbes of water-borne disease, that organism could be practically eliminated by storage and filtration, and, if chlorination processes were super-added, absolutely destroyed.

(7) There had been cases abroad in which the addition of chlorine to impure water, which had previously been responsible annually for an enormous amount of disease and death, had resulted seemingly in the almost complete elimination of water-borne diseases.

Insistence must, however, once more be stressed on the point that the more impure the sources of supply were, the more essential was it to provide uniformly a wide margin of safety by means of adequate purification processes, and to rely upon the advice of technically trained experts.

The second paper taken at the afternoon session was on "Protection of Underground Supplies of Water," and was by Mr. W. B. Cleverly, A.M.I. Mech. E., who is engineer to the Stourbridge and District Water Board. The paper contains a brief summary of the work carried out by the Advisory Committee on Water, which was appointed as one of the results of the Final Report of the Water Power Resources Committee which was issued in 1921. It was pointed out that the Advisory Committee itself issued in May of this year a report on the measures it suggests should be taken for the protection of underground water, and emphasised the urgency of the problem, in view of the ever-increasing demand for water, due to greater urbanisation and increased consumption per head, which must naturally follow a higher standard of living. The author explained that the report proposed that power should be given to the Ministry of Health to schedule areas in which the demands on underground water were such that special measures of protection should be adopted, and that in such area no fresh wells—except for domestic or agricultural purposes—or mines should be sunk until a permit had been obtained, the intention being, as regards mines, that the Minister of Health should act in consultation with the Minister of Mines, and that measures should be taken when new mines were sunk to avoid waste of needed water supplies. It was further proposed that, for preventing pollution, the statutory water undertakers should be given powers, already possessed by some authorities, for the protection of their supplies from pollution by the acquisition of land, by restrictions on its use or by requiring particular measures of drainage, &c., compensation being made in respect of any interest injuriously affected. The report, it was shown, concluded with a recommendation that the general statute law should be amended, brought up to date, and consolidated in one Act of Parliament at the earliest opportunity.

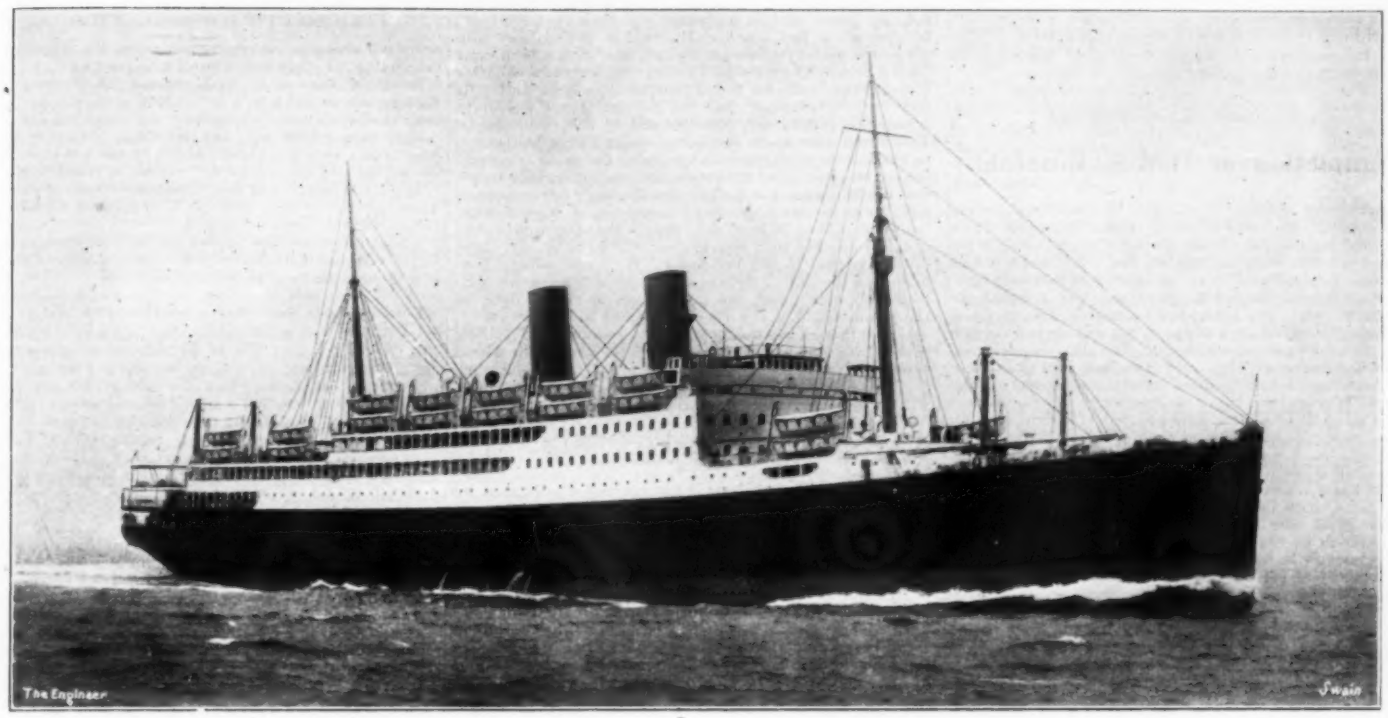
The next paper presented was on "The Financial Management and Control of Water Undertakings," and was by Mr. F. W. Davies, M.I. Mech. E., who is engineer and general manager, waterworks department, Nottingham. As it deals purely with matters unconnected with engineering, we do not propose to give a summary of this paper.

Transport for Public Cleansing Work.

On the Saturday the first paper presented dealt with "The Factors to be Considered in the Selection of Transport for Public Cleansing Work," and was by Mr. J. A. Priestley, the cleansing superintendent of the city of Sheffield. The author began by pointing out that transport might be roughly divided into three classes:—(1) Where a full load was carried

TWIN-SCREW MOTOR SHIP GRIPSHOLM

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LTD., NEWCASTLE-UPON-TYNE, BUILDERS



from one point to another, as in general haulage work; (2) where a full load was taken and delivered gradually from point to point, as in parcel delivery work; and (3) where a load was picked up from point to point and delivered in bulk, as in cleansing work. Of them, the two last were obviously the most costly, and cleansing work, coming chiefly into the third category and usually involving numerous calls and long carries, was, therefore, one of the most expensive. It should be the object of the cleansing officer to meet the latter conditions with the class of transport that would best combine efficiency with economy, but neither aim should be wholly subordinated to the other, particularly as regarded the sacrifice of efficiency to economy. It must be laid down that "efficiency" was the first fundamental principle upon which all cleansing work must be established. The second fundamental principle must be economy, which meant that efficiency must be secured at the last possible cost, and for that reason it was not enough to rest satisfied with a system that was efficient if it could be shown that equal or better results could be obtained at a less cost. That being the case, we could never be said to have reached finality in our methods, and every cleansing officer must keep in touch with every new development and be prepared to scrap both ideas and methods when experience or observation proved such action to be necessary.

The selection of the class of transport was only one of the matters to be settled, for there were many questions of importance other than the choice between horse and mechanical transport, or the adoption in the latter case of steam, petrol or electric wagons for the work, for it might be necessary to revolutionise methods without any change-over from horse to motor or *vice versâ*. Whatever the class of transport employed, there was one common factor influencing costs, and to it must be given first place in importance. Mr. Priestley then went on to discuss the effect on the question under consideration of such factors as "Waiting Time," "Length of Haul," "Physical Character of the District," "Gradients," "Condition of Roads," "Situation of Disposal Points," "Climatic Conditions," and "Accessibility of Premises," all of which, he said, exercised an influence on the subject. When all factors had been considered it might be found that no uniform system of transport would meet all the conditions, and a compromise between horses and motors would be found necessary. The advantage which the horse gained by its lower capital cost on waiting time might be balanced by the motor's advantage on travelling time and longer distances, and that usually resulted in the employment of the former on what might be called inner circuit work, and the latter on outer circuits. When that course was adopted, the economic distance for each class of transport must be determined, and that could only be done by actual trial.

THE proposed extensions of the Aliwal North electricity undertaking seem likely to be postponed for some little time. The Council's application for permission to raise a loan has, according to the South African *Power Engineer*, been refused by the Deputy Administrator.

The Swedish-American Motor Liner Gripsholm.

No. I.

THE twin-screw passenger motor ship Gripsholm, which was recently completed by Sir W. G. Armstrong, Whitworth and Co., Ltd., for the Swedish America Line, is undoubtedly one of the outstanding ships of the year. She is noteworthy on account of her size and the design and decoration of her public rooms, but chiefly because she is the first ship to be propelled by four-stroke cycle double-acting oil engines of the Burmeister and Wain type. Some preliminary details of her engines were published in THE ENGINEER of February 27th, but by the courtesy of her owners and builders we were recently privileged to inspect the ship, and in the present and following articles some account of her propelling and auxiliary machinery and of its arrangement will be given.

In the following table we have summarised the principal dimensions and particulars of the vessel:—

Hull Particulars.

Length overall, about	574ft. 6in.
Breadth moulded	74ft.
Depth moulded to boat deck	76ft. 6in.
Load draught	29ft.
Load displacement	26,000 tons
Deadweight carrying capacity	10,000 tons
Gross tonnage, about	17,300 tons
Service speed	17 knots

Cargo and Fuel Oil Capacities.

Ordinary cargo space	284,000 c. ft.
Insulated cargo space	13,200 c. ft.
Refrigerated ship's stores	11,000 c. ft.
Ordinary ship's stores	16,000 c. ft.
Mail and baggage space	10,000 c. ft.
Oil fuel capacity	2450 tons

Designed Passenger Accommodation.

	Normal.	Maximum.
First class	91	129
Second class	355	482
Third class	—	1006
Officers and crew	—	320
Total ship's complement, persons	—	1937

Main Propelling Machinery.

Type—Twin-screw, four-stroke cycle, double-acting, Burmeister and Wain motors.	
Number of cylinders per shaft	Six
Diameter of cylinders	840 mm., or 33 1/16 in.
Piston stroke	1500 mm., or 59 1/16 in.
Total shaft horse-power	13,500
Total indicated horse-power	16,300
Normal running speed	125 r.p.m.

Main Air Compressing Machinery.

Number of main Diesel-driven air compressors	Three
Type of engine—Four-cylinder, four-cycle, single-acting B. and W. pattern	700 B.H.P.
Total engine output, three sets	2100 B.H.P.
Normal running speed	170 r.p.m.

Main Electric-Generator Sets.

Number of Diesel-electric generators	Three
Type of engine—Three-cylinder, four-cycle, single-acting, B. and W. pattern	500 B.H.P.
Total engine output, three sets	1500 B.H.P
Total generator output, three sets	990 kilowatts
Normal running speed	200 r.p.m.
Circuit voltage	220 volts

The Gripsholm has been built to Lloyd's special survey, and is designed to conform with all the requirements of the British, Swedish, and American safety, emigration, and tonnage requirements. Her general appearance will be seen from the photograph taken on her trials in the North Sea, which we reproduce above. She has a straight raked stem with an elliptical stern, and is fitted with two funnels and two pole masts. In designing the hull special attention was paid to its strength forward, so that the ship can resist ice and slamming, while a cellular bottom is provided, which extends the whole length of the vessel between the peak bulkheads. Various compartments in the double bottom are utilised for the reception of oil fuel, lubricating oil, feed water, and water ballast. Throughout the ship's length there are placed ten transverse water-tight bulkheads, which have been so arranged that in the event of any two adjacent compartments being laid open to the sea the vessel could in moderate weather be safely navigated to port. It need hardly be said that the navigational and safety devices fitted are in accordance with the latest practice.

In the present article lack of space precludes us from illustrating or describing fully the passenger accommodation or the public rooms of the ship. The vessel takes her name from the Gripsholm Castle in Sweden, and the interior decorations and the furniture of the first-class and second-class accommodation are designed to conform with the general styles and periods of famous halls within that castle. The scheme has been well carried out and several of the rooms possess considerable artistic merit. The accommodation is arranged on eight decks downwards from the promenade deck. Above this deck there is the boat deck, with quarters for ship's officers and engineers, with direct lift connection to the engine-room.

Brief reference may be made to the principal deck auxiliaries. The steering gear is of the Hele-Shaw-Martineau electric-hydraulic type, and was supplied by J. Hastie and Co., Ltd., of Greenock. It is controlled from the bridge by a McTaggart-Scott telemotor gear. On the bridge the navigational equipment includes a Sperry gyro compass, a course recorder, and a helm angle indicator, whilst provision is made for a Sperry gyro pilot, which will be fitted later. Other bridge-operated machinery includes the hydraulic system for the operation of Stone's water-tight doors. For the working of the anchors and the cables an electrically driven windlass and two electric warping capstans are employed. They were supplied by Napier Bros., of Glasgow. The motors for driving the windlass and the capstans are, like most other motors on the ship, of the Swedish General Electric Company's make. The same firm supplied the various cargo winches. On the boat deck we noted four boat-hoisting winches, by Clarke-Chapman and Co., Ltd., of Gateshead, driven by Crompton motors. At this part of the ship there is also the emergency lighting set, which was supplied by L. Gardner and Sons, Ltd., of Patricroft.

The heating and ventilating of the ship is effected on the latest Thermotank principle, and particularly neat fittings are provided throughout the ship, which give a wide degree of control. In the officers'

and crew's quarters electric ventilating fans and steam heating are employed.

The Gripsholm has been constructed under the personal supervision of Director Filip Lindahl, of the Broström Lines Agency, and of the owners' naval architects, Sir John Biles and Co. It is anticipated that the new liner will make the voyage from Gottenburg to New York in about eight days.

In subsequent articles we shall deal mainly with the propelling machinery.

Completion of H.M.S. Emerald.

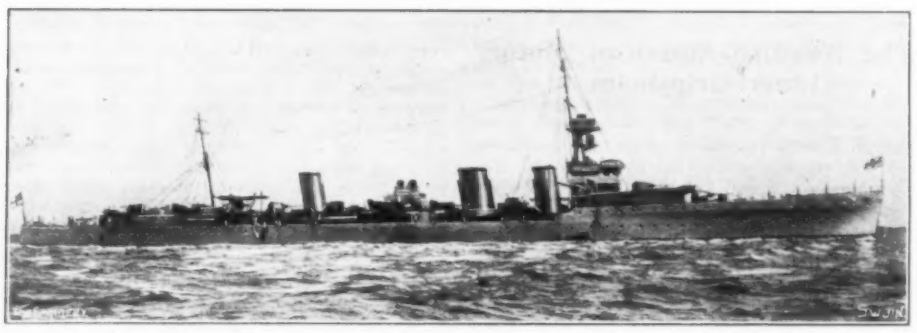
A WELCOME addition to our fleet of cruising ships has been made by the completion of H.M.S. Emerald, which has been running her trials in the Channel during the present month. She belongs to the "E" class, which consisted originally of three units, but the cancelling of the Euphrates immediately after the war reduced the number to two. The Emerald's sister ship, Enterprise, is now being fitted out at Devonport, but will not be ready for sea until next summer or autumn. The class was designed by Sir E. Tennyson d'Eyncourt in the last year of the war, the idea being to obtain a speed equal to that of the swiftest German cruisers then being built or likely to be built, and at the same time to adopt a new system of distribution for 6in. guns which had been suggested by gunnery officers on the basis of war experience. The Admiralty sketch design called for a speed of 33 knots in light condition and 32 knots under full load. This demand necessitated an increase in length much beyond that of earlier light cruisers, and the installation of machinery developing power far in excess of anything previously attempted in such vessels. A further requirement was the provision of a loftier forecastle and a higher freeboard throughout, to improve the seaworthiness of the ships and keep them dry when steaming into a head sea. All these desiderata have, it is believed, been satisfactorily met in the Emerald and her sister ship, which therefore embody in large measure the lessons of war experience.

The Emerald was laid down at Armstrong's Walker yard on September 23rd, 1918, and after being launched on May 19th, 1920, was towed to Chatham Dockyard for completion. It has taken nearly five and a-half years to finish her, the rate of work having been slowed down presumably for financial reasons. She has a length of 535ft. between perpendiculars and of 570ft. overall; her extreme breadth is 54½ft., and her draught at a normal displacement of 7600 tons is 16½ft. The machinery, which was supplied by the Wallsend Slipway and Engineering Company, Ltd., resembles in type that of the "Shakespeare" class of flotilla leaders, but two sets are provided. The four shafts are turned by geared turbines, those for the wing shafts being housed in the forward engine-room, while the inner shaft turbines are in the after engine-room. At full power an aggregate of 80,000 shaft horse-power is generated. The eight water-tube boilers of Yarrow small-tube type are disposed in four rooms, three of which are forward of the magazines for the midship guns, the fourth being abaft the forward engine-room. The uptakes from the four boilers in the two central rooms are led into one large funnel, and those from the forward and after group of boilers into separate funnels. This arrangement results in the uneven spacing of the funnels which lends such an odd appearance to the ship, reminiscent of the "Lion" class of battle-cruisers. The supply of oil fuel normally carried is 650 tons, but there is stowage space for a maximum of 1600 tons.

Protection to the hull is furnished by a broad belt of armour extending almost the entire length of the ship, and rising amidships to the level of the upper deck. Including the skin plating, the thickness over vital parts is 3in. Towards the bows it decreases to 1½in., and at the stern to 2in. At the rear end of the after engine-room a 1in. bulkhead is worked in, it being an innovation in light cruiser practice. Great care has been bestowed on the horizontal protection of steering gear, machinery, and magazine spaces, and to compensate for the absence of anti-torpedo bulges—which would have involved either a reduction in speed or a substantial increase in dimensions—the system of duplicating the propelling machinery has been so far followed that there is a complete separation, longitudinally, of the engine and boiler-rooms. Moreover, the oil tanks have been arranged in such manner as to offer the maximum degree of resistance to sub-surface explosion. On the whole, therefore, the Emerald, notwithstanding her moderate size and fine lines, would not be likely to fall an easy victim to torpedo attack.

She is armed with seven 6in. guns of the latest model, five disposed on the centre-line and two on the beam. She carries also two 4in. guns, two 2-pounder automatic guns, and eight Lewis machine guns, all of which could be used against aircraft. The provision of twelve torpedo-tubes, on above-water triple mountings, attests the great importance now attached to the torpedo armament of light cruisers. The complement numbers 574 officers and men.

On the conclusion of her trials the Emerald will proceed to the East Indies Station, where she will eventually be joined by her consort the Enterprise, the flagship of the Squadron being the Effingham—a ship of 30¼ knots, armed with seven 7.5in. guns. The collective speed and fighting power of this Squadron will thus be very high. In view of the fact that the Emerald is the swiftest ship above the destroyer category which has, so far, been built for the British Navy, her performance under trial is a matter of legitimate interest to all marine engineers, and it is therefore to be hoped that the Admiralty will see fit to release for publication some details of the steam trials. This is the more to be desired in view of what we believe to be the very exaggerated accounts of the speed of certain foreign cruisers which are broadcast from unofficial sources. It is becoming quite customary for the daily newspapers to refer to every new American, Japanese, or other foreign cruiser as a 35 or 36-knot ship, figures that the professional engineer accepts with reserve, but which, no doubt, carry full conviction to the lay mind. We have enough confidence in the skill of British shipbuilders and marine engineers to predict that the publication of official data on the steam trials of the Emerald would show this vessel, designed though she was nearly eight years ago, to be little if at all inferior in velocity to the later and much-advertised products of foreign industry.



H.M.S. EMERALD

BRITISH RAINFALL, 1924.

"BRITISH Rainfall, 1924," has now been published by H.M. Stationery Office, and can be obtained through any bookseller, price 15s., postage 4d. extra.

The volume contains a full account of the rainfall of the year under review. It includes maps, tables, and descriptive matter showing the distribution of rainfall in each month and for the whole year and its relation to the average; studies of the distribution on individual days of particular interest; discussions of heavy falls of rain in short periods; of the number of days with rain, and of the spells of dry or wet weather during the year. Sections are devoted to the measured duration of rainfall and to records of evaporation and of percolation through the soil. Articles on various branches of rainfall research and a report on the work of the organisation are also given. The total rainfall for the year at each of 4886 stations is placed on record.

The year 1924 is shown to be the wettest year since 1903 for the British Isles generally. In parts of South Devon, Co. Mayo and Co. Sligo the year was the wettest since before 1868. In each month from April to October the rainfall was above the average. On no other occasion since before 1881 had there been so long a sequence of wet months. The early spring was equally remarkable, for during February and March of 1924 less rainfall was recorded over the whole British Isles than in any other February and March since before 1881. Outstanding features of the year were the widespread deluge in the great thunderstorm of May 31st, when floods were general in some western and northern districts, and the unprecedented local downpour of 9.4in. at Cannington, in Somerset, on August 18th.

The abnormal rainfall at Cannington is the subject of a separate report and photos showing some of the damage are reproduced. Statistics are also given showing the relative dryness or wetness of each month and year in the series 1881 to 1924 for England and Wales, Scotland and Ireland separately and for the British Isles as a whole.

TUNGSTEN FILAMENT LAMPS.

THE British Standard Specification for Tungsten filament Electric Lamps B.S.S. No. 161 has now been enlarged by adding the following three new schedules:—Schedule for normal vacuum train lighting lamps, schedule for normal gas-filled train-lighting lamps, schedule for traction vacuum type lamps—series burning. The adoption of these schedules by those responsible for train and tram lighting will reduce the variety of types of lamps used for this purpose, and do away with the large number of differing voltages for which these lamps have had to be made in the past. These schedules now published will be included in loose pamphlet form in B.S.S. 161, until that document is revised, when they will be incorporated in it. The new edition is expected to be ready early in the New Year. Copies of the three additional schedules may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOCOMOTIVE WHEEL DIAMETERS.

SIR,—I would be very much obliged if Mr. Ahrons would clear up a little point upon which I am rather hazy.

Mr. C. Williams in his book entitled "A Register of the Locomotives of the L.N.W.R." (1922), gives the size of the coupled wheels of the "Claughton," "George V.," and "Precursor" classes as 6ft. 6in., and that of the "Prince of Wales" class as 6ft., while Mr. Ahron's figures for the first three classes are 6ft. 9in. and 6ft. 3in. for the "Prince of Wales" class.

Again, the cylinders of the "Claughton's" are given by Mr. Ahrons as 16in. by 26in., while Mr. C. Williams in his book gives the cylinders as 15½in. by 26in.

These differences have puzzled me for some time, so that I will be very glad if Mr. Ahrons will furnish me with an explanation through the medium of THE ENGINEER.

M. BARRY.

Dowlais, Glam., South Wales, November 20th.

[In reply to Mr. Barry's letter, the diameters of the driving wheels of the L. and N.W.R. express engines are nominally 6ft. 6in. and 6ft., though actually 6ft. 9in. and 6ft. 3in. respectively. In Ramsbottom's and also during the early part of Webb's time the 6ft. 6in. coupled wheels, when new, had a diameter of 6ft. 7½in., but in later years thicker tires were provided, making the wheels 6ft. 9in. Similar nominal diameters were formerly used on other railways, such as the Midland, on which 6ft. 8½in. wheels were termed 6ft. 6in. in Matthew Kirtley's days. S. W. Johnson altered this, and the wheels were afterwards known by their real diameters; other railways, except the London and North-Western, adopted a similar nomenclature. A 6ft. 9in. wheel, when tires have been turned down and worn as thin as would be safe, will eventually have a diameter of about 6ft. 6½in. to 6ft. 6¾in., after which the tires would have to be renewed.

The four cylinders of the "Claughton" class were originally officially stated to have a diameter of 16in., and in the particulars of the trials of the engine Ralph Brocklebank, given by C. Bowen Cooke in the "Proc.," Inst. C.E., 1914, this figure was given. I believe that later engines were made with 15½in. cylinders. This would allow for re-boring, when worn, to 16in. diameter, whereas the similar enlargement from 16in. to 16½in. might possibly cause too great a drain on the boiler.—E. L. AHRONS, Nottingham, November 20th.]

THE LIMA LOCOMOTIVE.

SIR,—The use of a four-wheeled truck under the fire-box of the notable Lima locomotive recently built for the Boston and Albany Railroad, although a feature of interest, is neither an innovation nor a novelty.

Speaking generally, it is not even new in American practice, but may be new in its application to an eight-coupled engine with a leading pony truck. In 1915 the Philadelphia and Reading Railroad had in service four express engines of the 4–4–4 type. These engines, which were remarkable for having no less than 65½ English tons jointly on the two coupled axles, had 23½in. by 26in. cylinders, and 6ft. 8in. driving wheels. The heating surface, including that of a thirty-two-element superheater, totalled 3170 square feet. The grate area amounted to 108 square feet, and the steam pressure—another noteworthy feature—was 240 lb. per square inch. The weight of the engines in working order was 103 long tons, and that of the tenders 71 tons, making a total of 174 tons.

An engine of the same wheel notation was designed and built by Maffei, in 1906, for the Bavarian State Railways. This was a four-cylinder compound superheater locomotive, with 16½in. high-pressure and 24in. low-pressure cylinders; stroke of all four pistons, 25½in. The four-coupled wheels were 7ft. 2½in. in diameter; the heating surface was 2722·28 square feet; the grate area, 50·5 square feet; and the working pressure 206 lb. per square inch. The drive was wholly on the first coupled axle, and the weight available for adhesion was 32 tons. Weight of engine, 82 tons; with tender, 135½ tons.

In 1910 the Northern Railway of France also built a 4–4–4 four-cylinder compound, the outstanding feature of which was a large water-tube fire-box having a grate area of 38 square feet. The steam pressure was 256 lb. per square inch, and the total heating surface was 3406·95 square feet. The cylinder dimensions were:—High-pressure, 13¾in. by 25½in.; low-pressure, 22¼in. by 25½in.; the four-coupled wheels were 6ft. 8½in.; and the weight of the engine was 76 tons; total weight of engine and tender, 118 tons 16 cwt.

The Nord, again, constructed, it will be remembered, a "Baltic," or 4–6–4 superheater tender engine in the same year (1910). This also had a water-tube fire-box. The grate area was 46 square feet; the total heating surface, 3899·73 square feet; and the steam pressure, 227 lb. The engine weighed 100 tons 7 cwt., and the double bogie tender 55 tons 12 cwt., making a combined total of 155 tons 19 cwt. The 6ft. 8½in. six-coupled wheels were driven by 17½in. high-pressure and 24½in low-pressure cylinders, with a piston stroke of 25½in. for the former and one of 28¾in. for the latter. A generally similar engine, but having an ordinary non-water-tube fire-box of the Belpaire kind, was also built by the Nord Railway Company. All the Nord engines had a divided drive.

Having regard to the revival of the four-wheeled trailing truck in the case of the Boston and Albany engine, a 2–8–4, these earlier examples of the employment of such a truck are interesting. In each case the size and weight of the fire-box constituted important factors.

F. W. BREWER.

Stevenage, Herts, November 21st.

INSTITUTION OF MECHANICAL ENGINEERS.—The dinner arranged to be held at the Connaught Rooms, Great Queen-street, London, W.C. 2, has been cancelled owing to the death of Queen Alexandra.

CORRECTION.—In referring to the motor ship Dolius in our journal note of last week, we stated that in the recent outward voyage of the vessel 9847 miles of the total distance were covered at "full rated power." The last words should read at "full speed," the period referred to being that during which the engine-room telegraph stood at full speed ahead and the speed of the engines was not reduced by bridge orders.

Railway Matters.

THE Dover-Calais turbine mail steamers Biarritz and Maid of Orleans of the Southern Railway are to be converted into oil-burning vessels. The Biarritz has left Dover for the Clyde, where the work is to be carried out.

THAT there were not many railway accidents in the severe fog that prevailed in the North of England last week is high testimony to the great care exercised in railway work in such times. There was, however, a slight collision between two passenger trains at Wincobank North Junction, L.M.S. Railway, on Friday evening.

THE Canadian Pacific Railway will construct an extension from the Angliers terminus of the International and James Bay Railway, and work will start before 1928, if not next year. The line will follow the colonisation road built by the Department of Mines, and will extend about 40 miles. The survey shows that the railway will be built without much difficulty.

IT is hoped to bring into service in May next two complete trains, of ten Pullman cars each, to run non-stop between Calais and Paris. The cars are of all-steel construction, and a feature will be that passengers will retain the same seat throughout the journey, and their luncheons or dinners will be brought to them in their places. In a trial run made the other day, the distance of 298 kiloms. (185.17 miles) was covered in less than three hours.

A LOCOMOTIVE on the Wheeling and Lake Erie has recently been named William Patterson, as an appreciation of a servant of that name who had been a driver for fifty-five years, during which period he had not had an accident that caused a death, and only one that led to any personal injury. Patterson is in his eightieth year, and had to leave the footplate owing to his eyesight becoming impaired, but he is still in the service of the company.

RECENTLY an oil-burning locomotive on the Great Northern (U.S.A.) made the run through from Seattle to St. Paul, and then back to Seattle, a distance of 3571 miles, in 99 hours 45 minutes. The enginemen were changed thirteen times on each journey, but the engine made no other stops than for ordinary locomotive purposes. On the outward journey eighteen cars, laden with silk, were taken. The value of the consignment was such that the interest thereon was several hundred dollars a day, which fact accounts for the expedition shown.

SPEAKING at a social gathering lately, Lord Ashfield, the chairman of the Metropolitan District, the Tubes, and the London General Omnibus Company, said that in 1900 every man, woman and child made, on an average, 178 journeys a year; now the average was 460. The number carried by train, omnibus and tram was then 820 millions a year; now it was 3500 millions. He estimated that by the end of the next twenty-five years Greater London would have a population of not less than eleven millions, and that the number of journeys then would be 7200 millions.

AMONG the works for which the railway companies seek powers in next year's session of Parliament are:—A line to be known as the Mid-Nottinghamshire Joint Railway, to be constructed by the London, Midland and Scottish and the London and North-Eastern, in place of the opposing schemes withdrawn during the present session; widening of the Cardigan branch of the Great Western; sundry connecting lines in the London area and the acquisition of Newhaven Harbour by the Southern Railway; widening and improvement near Stamford Brook on the Metropolitan District; and an entirely new line by the Metropolitan between Willesden Green and Edgware-road.

THE Ministry of Transport railway statistics for the month of August have just been issued as a Stationery Office publication, price 3s., and make very unsatisfactory reading. Compared with the corresponding period of 1924, there was a decrease of 0.6 per cent. in the number of passenger journeys, of 5.8 per cent. in the receipts from passengers and of 4.4 per cent. in the passenger train traffic. Moreover, there was an increase of 3.2 per cent. in the passenger train mileage. The tonnage of coal, coke and patent fuel was 21.8 per cent. less and of all freight traffic 15.6 per cent. less. The freight train receipts suffered a decrease of 8.8 per cent., but it is a satisfaction to know that there was a reduction of 4.2 per cent. in the freight train mileage. The average train load, owing to the fall in mineral traffic, fell from 128¼ to 121¼ tons, and the net ton-miles per engine hour from 442¾ to 419¼.

AN item in the evidence given by Mr. Clower at the Railway Wages inquiry last week reminds us of a controversy that reached rather an acute stage some eighteen to twenty years ago. The Amalgamated Society of Railway Servants maintained that there were 100,000 railway servants getting less than £1 a week. The *Railway News* claimed that that was not so, and gave figures in support of that contention. Both parties were, in a sense, right, but the latter took into account what the men drew in wages, which included overtime and Sunday duty. If the union had spoken of the men's rate of pay, it would have been right. That this was so was confirmed by a census taken by the Society in 1907, and published in 1908, wherein it was shown that 100,930, or 38.8 per cent., of the members were rated at 20s. or under per week, of whom 36.7 per cent. were in England and Wales. The Board of Trade, during the same year, held an "Earnings and Hours of Labour Inquiry" as to the railway service, but for some reason or other the report—Cd. 6053—was not issued until February, 1912, and therein it was indicated that 78,191 railway servants were rated at less than 20s. per week and 55,221 at 20s. and under 21s. Now, Mr. Clower has acknowledged that the claim made by the Amalgamated Society had considerable justification. He said on Tuesday, the 17th inst.: "It was only fair to add that it was strongly represented by the trade unions that there were a large number of railway employees receiving in the pre-war period wages of less than 20s. a week. There was some measure of justification for that, and the average pre-war rate of wages of passenger porters was 19s. 2d."

Notes and Memoranda.

ACCORDING to Mr. A. K. Hamilton Jenkin, the Cornish tin mining industry is far from being worked out and is reviving. There are now six large mines in the producing stage and over 2000 men are employed.

WHEN the new stern frame for the White Star Liner Olympic was taken from the Darlington forge to the docks at Middlesbrough, one Sunday recently, it was so large that both lines of railway had to be clear, and even then it overhung the railway platforms it passed on the way.

IT is said, in the *Engineering News-Record*, that the adoption of electrically-welded joints, instead of riveting, for a California pipe line will effect a saving of 4,000,000 dollars. The line is 85 miles long and ranges in diameter from 60in. to 65in. The pressure head will be about 400ft.

THE successful fusion of carbon by Dr. Alterthum and other German chemists is reported through American sources. A carbon rod was capped at each end by electrodes of copper and high-voltage current applied. The melting point of carbon was determined as about 6300 deg. Fah.

THE following formula for a marking ink for chemical porcelain is given by the Coors Porcelain Company of America:—18.8 grams of commercial black oxide of cobalt, 1.2 grams of bismuth subnitrate, 15 cc. of oil of turpentine, and 15 drops of Dresden thick oil. The ingredients are thoroughly mixed by grinding.

A DIAMOND substitute is, according to the *Iron and Coal Trades Review*, claimed to have been discovered by the Roechling Steel Works at Wetzlar, which has succeeded in producing an alloy of wolfram and wolfram carbides that will melt at a temperature of about 3000 deg. Cent., and will last longer in scientific work than a diamond. The hardness of the new alloy, which will be placed on the market under the name of Thoren, is only about 2 per cent. less than that of the diamond.

SPEAKING at Middlesbrough recently, Mr. Arthur Dorman commented on the great progress made in recent years in the output and conditions of steel furnaces. Twenty-two years ago, he said, only six casts per week were obtained from a small furnace, giving a weekly make of 200 tons, or even less. To-day they secured fourteen casts from a large fixed furnace, with a production of 1100 tons to 1200 tons per week. He did not think they had reached the capacity limit of furnaces, and he understood that Mr. Benjamin Talbot was planning a furnace of 500 tons capacity, with a probable output of 2000 tons to 3000 tons per week.

IN the November issue of *World Power*, Mr. J. B. C. Kershaw, in the course of an article on the Hell Gate power station at New York, states that last June the station generated over 82 million units with a maximum load of 198,000 kilowatts, giving a load factor of well over 50. A boiler efficiency of 92 per cent. is claimed for this station, and the author suggests that the fact that this high figure has been obtained, together with the low fuel consumption of 1.8 lb. of coal per kilowatt-hour, indicates that the older method of firing employed at this station may not succumb so quickly to pulverised fuel firing as the advocates of the latter would have one believe.

A PAPER on the use of vegetable pulps as binders in the making of coal briquettes was recently presented to the South Wales Institute of Engineers, by Mr. C. J. Goodwin. In it the author said that the total cost at the factory of pulp binder ready for use would vary between 50s. and 100s. per ton, on a dry weight basis, and of this total 20s. represented the cost of fermentation and preparation. With anthracite, 4 per cent. of binder was ample, equivalent in England to, say, 3s. on the average for binder cost per ton of ovoids produced. The extra cost of drying and "cooking" might reasonably be taken at 9d., making a total cost of 3s. 9d. per ton exclusive of briquetting costs. The actual cost of briquetting, overhead charges, &c., might be taken as the same as when using pitch.

SOME tests have been carried out at Woolwich by Mr. E. F. Figg on the best paint for protecting steel surfaces subjected alternately to the action of salt water and air. A test of eighteen weeks sufficed to indicate the unsuitability of many of the paints employed, and those included three of the proprietary brands, and most of those prepared with a varnish vehicle. Of the latter, that containing tung oil varnish seemed to be the most promising up to the time the plate employed was lost in the river, 17 weeks after it had been put in place. Nearly all the paints containing bituminous material fared badly. The results indicate that for the conditions given the best protection is afforded to steel work by two coats of a special paint consisting of zinc oxide and zinc dust in raw linseed oil. A similar protection is afforded by one coat of red lead in raw linseed oil followed by one of white lead in the same vehicle, but the resulting surface was not so smooth at the end of the test.

IN a paper on "Electric Alloy Steel," read before the American Iron and Steel Institute, the author, Mr. F. E. Clark, came to the following conclusions:—Although the electric furnace is now on a very firm basis in the industrial world, it has not taken the place it justly deserves for a number of reasons. Early troubles built up considerable prejudice which has not entirely disappeared, while the very keen business competition existent at this time occasionally is a factor in deciding against the choice of electric steel. Some of the early installations made in open-hearth plants met with failure because of the attempted application of open-hearth steel-making methods. Installations made in plants operating crucible furnaces invariably met with immediate success, perhaps because of the fact that the crucible man had first in mind the production of a quality product. It is a fact that to-day the quality of electric steel is on a higher plane than it ever has been before, and one factor in this connection has been the tendency toward the use of higher grade raw materials. One possible application of the electric furnace is in the making of rails. As far back as 1912, microscopic examination of hundreds of specimens indicated a marked superiority of the electric rail to that made by the open-hearth process, it being freer from dirt, slag inclusions and segregates.

Miscellanea.

AN International Sample Fair is to be held in Havana from February 5th to 24th next.

A SUM of £1,000,000 will be available from the Australian Commonwealth Government in the current financial year for main roads grants to the States.

IT is reported that work is to be started very shortly at the Bembe Malachite Mines, Angola, and that motor lorries will be used to bring the ore down to the coast.

DURING the first six months of 1925, imports into Bulgaria totalled 3,694,394,450 levas (£5,600,000)—an increase of nearly one million levas over imports during the first half of 1924.

THE new sugar factory at Raymond, Alberta, started operations on October 23rd. It will probably be the first of a number to be established in the irrigated districts of Southern Alberta. It is expected to handle over 75,000 tons of beets this year.

CANADIAN exports of pulp and paper for the year ended September 30th, 1925, were valued at 147,961,001 dollars, being an increase of nearly 9,000,000 dollars over the preceding twelve months. Newsprint exports alone amounted to nearly 95,000,000 dollars, as compared with 90,300,000 dollars.

ACCORDING to the *Chemical Trade Journal* and *Chemical Engineer*, large and valuable deposits of zinc ore have been found on the properties of the Northern Exploration Company and Norwegian companies in Spitzbergen. It is believed that high-grade zinc can be landed at low cost to the British market.

PROVISIONAL arrangements have been made for the promotion of a company in London to provide an air service between Georgetown, British Guiana, and the diamond bearing areas of the Colony, but until the British Guiana Government reaches a decision regarding the proposal to establish an interior railway the matter will remain in abeyance.

THE Trinidad wireless system is being reconstructed and modernised. An installation of higher power is being supplied to the Port of Spain Station, and the apparatus previously in use at Port of Spain is being transferred to North Post to provide more efficient communication with ships. The former station will have a range of about 1000 miles and the latter of about 700 miles, and the opportunity will be taken to increase the efficiency of the installation at Tobago.

IT is reported in *Canada* that the plant of the Laurentian Power Company at Seven Falls on the St. Maurice River, is to be increased in capacity from 18,000 to 24,000 horse-power. Negotiations have been proceeding between Winnipeg Hydro-electric Department and the officials of the Manitoba Pulp and Paper Company. As a result there is a possibility that the power site at Pine Falls will be developed jointly by the city and the company on the basis of 60,000 horse-power to the company and 40,000 horse-power to the city.

THE Esthonian Legation in London reports that the capital of Esthonia, Reval, has hitherto been served by a tramway system of cars propelled by internal combustion motors. With the establishment of several large electric power plants in the country it was decided to electrify the tramways, and in October last the first electric tramway line was inaugurated in Reval. The cars were built in Esthonia and the rails for the permanent track were purchased in the United Kingdom. The total amount so far expended on the line is 60 million E. mks. Further extensions of the electric tramway lines will be commenced shortly.

A REPORT by the Explosives in Mines Research Committee on "Electrical Exploders for Shot-firing in Coal Mines," has just been published by the Safety in Mines Research Board. The use in coal mines of permitted explosives, which are of the type of high explosives, requires the employment of a denotator which, according to present practice, is fired by a magneto exploder. For safety and efficiency the magneto exploder must be incapable of igniting firedamp, but must be fully capable of igniting the detonator. The problems discussed in the present report are those of devising safe and reliable exploders which will fulfil these conditions, or alternative means of providing the current necessary to actuate detonators.

THE manufacture on a commercial scale of solid-drawn tubes of stainless steel and iron has been started by the Weldless Steel Tube Company, of Wednesfield, Wolverhampton. The mechanical properties of the tubes can be varied within wide limits by suitable heat treatment, as the following analyses indicate:—In stainless iron, less than 0.10 per cent. carbon, maximum stress, 35 to 45 tons per square inch; elongation, 25 to 35 per cent.; reduction of area, 55 to 65 per cent.; yield point, 25 to 35 tons per square inch; Izod impact figure, 50 foot-lb. minimum. In mild stainless steel, 0.10 to 0.20 per cent. carbon, maximum stress, 40 to 60 tons per square inch; elongation, 15 to 25 per cent.; reduction of area, 50 to 60 per cent.; yield point, 30 to 45 tons per square inch; Izod impact figure, 25 foot-lb. maximum.

WORK on the Lobito Angola Harbour contract is, according to an official report, progressing slowly. The project there consists of the building of the sand spit of a wharf 420 metres in length, with a depth alongside at low water of 36ft., fully equipped with all appliances for the handling of cargo, and with custom house, transit sheds, and a railway track to connect with the main line. The method of construction adopted is comparatively simple. A series of mass concrete caissons, on steel cutting edges measuring 50ft. by 28ft., is sunk into the sand, by means of grabs, to a depth of 56ft. below the surface, i.e., to 48ft. below the lowest water level. These are then plugged, filled up and keyed together, the whole then forming the foundation for the wharf proper. So far nine of these caissons have been sunk to the depth required and are now being plugged and keyed, while five more are in process of being sunk. The weight of each caisson when complete will be about 3600 tons. When the fourteen are down, they will give a total length of about 220 metres of wall.

PUBLIC WORKS, ROADS AND TRANSPORT EXHIBITION

(*For description see page 586*)

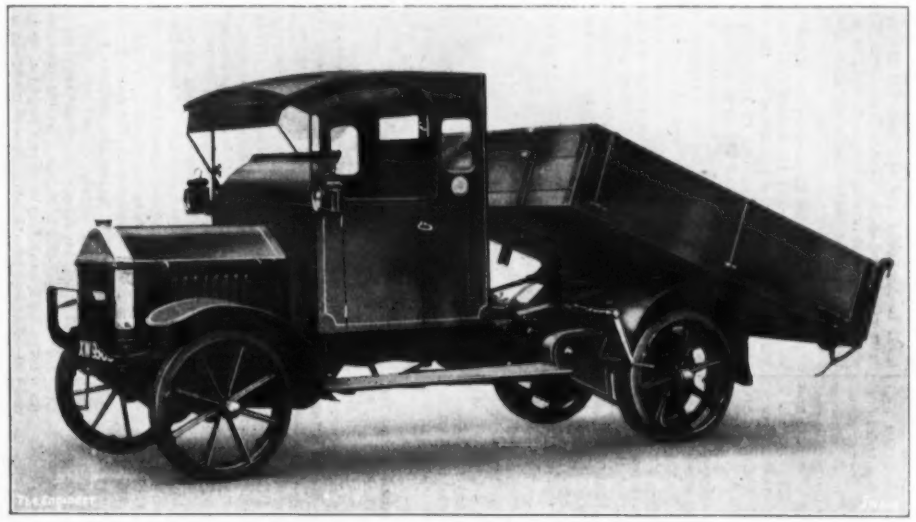


FIG. 1—GRAVITY-TYPE TIPPING MOTOR WAGON—LACRE

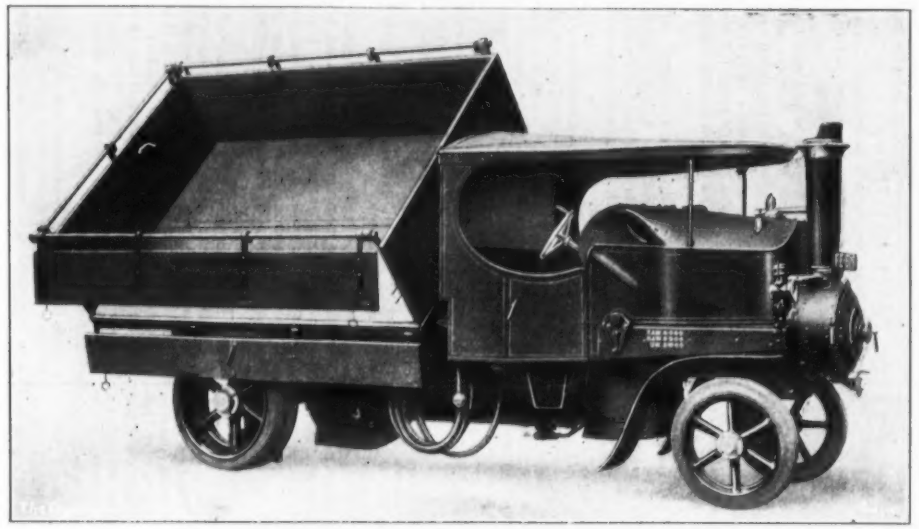


FIG. 2—THREE-WAY TIPPING STEAM WAGON—ROBEY

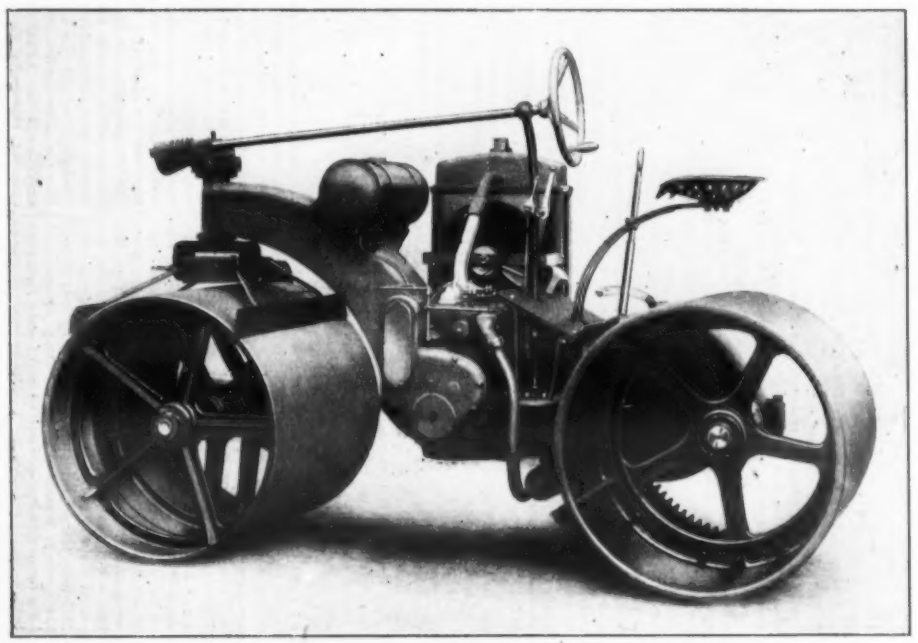


FIG. 3—3-TON "CLEAR-SIDE" TANDEM ROAD ROLLER—ROBEY

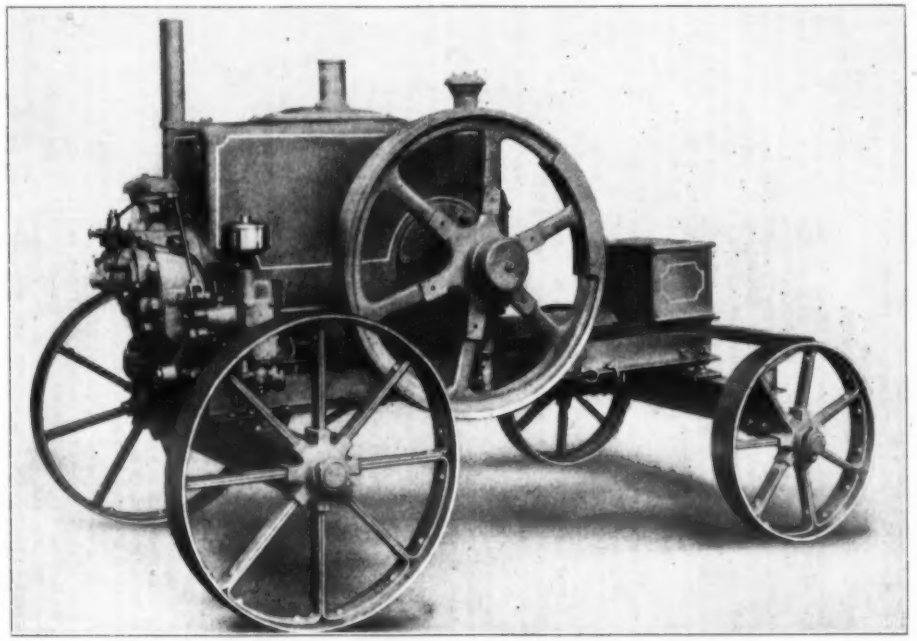


FIG. 4—20-22 B.H.P. PORTABLE OIL ENGINE—RUSTON AND HORNSBY

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SIXTEEN-PAGE SUPPLEMENT—The Metallurgist.

The Metallurgist

THE NOVEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE

QUEEN ALEXANDRA.

We record with deep regret the death of H.M. Queen Alexandra, which took place at Sandringham on Friday evening, Nov. 20th.

THE ENGINEER.

NOVEMBER 27, 1925

The Problem of the Submarine.

It is as easy to understand as to sympathise with the motives which have impelled the Committee of Lloyd's, through its chairman, Mr. Percy Mackinnon, to make a public appeal for the abolition of all submarines. The loss of M 1 is the fourth submarine disaster to occur since the war, each involving the total destruction of vessel and crew. One hundred and ninety-three officers and ratings, the very pick of the Navy's manhood, having gone to their death in this tragic fashion, there is a not unnatural tendency on the part of the public to challenge the need of such a heavy toll of life in time of peace. The chairman of Lloyd's has denounced the submarine as "a deadly machine, which treacherously destroys those in charge of it, and, it is feared, inflicts slow torture as well as death." His plea for its abolition has been warmly taken up in influential quarters, and the Government has already been invited to convoke a Conference of the maritime Powers to give effect to the suggestion. There is no doubt that the world at large would stand to gain much and lose nothing by the extinction of a naval weapon which, during its relatively brief career, has caused a disproportionate amount of suffering to humanity. Long before the Great War the submarine's victims were numbered by the hundred. During the war its persistent misuse by one of the belligerents covered it with such obloquy that its legitimate achievements have been obscured. Hence it remains a weapon of sinister associations, and we believe that its formal repudiation by the Powers would be hailed with an almost universal chorus of approval.

Despite unceasing efforts to extend the margin of safety by improvements in design and equipment, submarine navigation is undoubtedly still attended with special hazards from which the surface ship is immune. We are not unmindful of the Admiralty's contrary opinion, as set forth in a Fleet Order of November 21st, 1924, that "the development of submarines has now reached such a stage that it is no longer practicable to adhere to the system of restricting service in them to volunteers." This order went on to announce that "although volunteers will be called for as hitherto and be given preference in selection, officers will be appointed and ratings drafted for service in submarines as requirements may demand." Clearly, therefore, the Admiralty does not consider that men doing duty in submarines incur risks any greater than those incurred in other branches of the naval service. As to this, however, we fear the public will not be so easily satisfied. Questions are being raised as to whether our underwater craft are furnished with safety appliances of tested value. They would, of course, have been useless in the case of M 1, in view of what we now know to have been her fate; but the moment is opportune for drawing attention to the possible utility of such devices. It has frequently been suggested that the provision of floats, which the crew of a submarine in difficulties could release, might assist materially in the prompt location of the vessel. Such floats, fitted with electric syrens, smoke-boxes or flares, would broadcast a warning over a wide area of sea, whether in daylight or in darkness. Telephone buoys are, we believe, invariably fitted to the submarines of certain other navies; it would be interesting to learn whether they have been adopted in our service. Since it is too much to hope that the Navy has suffered its final submarine disaster, it would surely be prudent to take such precautions as are calculated to mitigate the danger. We can surmise what happens when a submarine is run down by a surface vessel, as in the case of the H 24, the L 24, and the M 1, to enumerate the three instances of this kind which have occurred since the war. But occasionally a boat vanishes mysteriously—*e.g.*, the K 5 in January, 1921—without leaving a hint as to the cause. The growth in dimensions, so far from reducing the element of risk, seems to have magnified it. Rapid diving, a very essential form of training, is an operation more perilous to the large submarine than to her smaller consorts. In vessels of the "K" and "M" classes it probably necessitates the admission of water to the tanks at the rate of some 200 tons a minute, and if the slightest delay ensues in getting the compressed air blast to act, the boat may plunge to a depth beyond the limit of recovery. That is one reason why the huge submersible cruisers which have been projected abroad are viewed askance by naval men in this country. For the present, however, we are less concerned with the technical aspect of the submarine problem than with its wider significance as an international question. Great Britain's position was clearly defined at the Washington Conference, when Lord Balfour invited the associated Powers to join with us in discarding the submarine. The arguments advanced in favour of that proposal did not include any reference to the dangers inherent in submarine navigation, probably because it was recognised that the development of a potent weapon was not likely to be arrested by considerations of personal safety. Those who urge the scrapping of the submarine would do well to rest their case on firmer ground. The British Government, as Mr. Baldwin intimated in Parliament last week, has not altered the views it expressed at Washington four years ago. It is still prepared to banish submarines from the Navy and refrain from building any further vessels of that type, on condition that the other Powers will pledge themselves to similar action. Submarine disarmament, to be effective, must necessarily be reciprocal and universal. It is a complete mistake to assume that the submarine is worthless for British naval purposes. It has qualities which render it as valuable to us as to other nations, provided it is employed in a strictly legitimate manner. We are not able to share the view, which appears to be widely held abroad, that this country alone has reason to fear the submarine. That our dependence upon seaborne supplies renders us peculiarly vulnerable to commerce-raiding tactics is true enough, but having successfully withstood a submarine *guerre de course* which lasted four years and was waged with a determined ruthlessness without parallel in history, we may reckon with some confidence on surviving any future attack of this kind. The real menace of the German U-boat campaign lay in the novelty of the means by which it was conducted, and our

consequent lack of preparedness. But once the effect of surprise had worn off, and our defences had been readjusted to cope with the new conditions, it was not long before we gained the upper hand. If there be any persons abroad who imagine that a future submarine offensive against British merchant shipping would bring this country to its knees, we can assure them in all sincerity that they are deluding themselves. Moreover, the five Powers in conference at Washington all accepted the Root resolution stigmatising commerce destruction by submarines as barbarous and contrary to international law, and although this appendix to the Naval Limitation Treaty still awaits ratification, the fact that it was endorsed in principle by each of the Powers concerned implies a moral obligation which cannot lightly be ignored.

Circumstances have conspired to make the submarine a provocative element in world politics. It has acquired an ominous significance from which every other type of warship is free, and its permanent removal could not fail to have a tranquilising effect on international relations. That it possesses a distinct value as a weapon of naval warfare we freely admit. On the other hand, its powers have been greatly exaggerated. The elimination of the submarine would not modify in any appreciable degree the relative standing of the various navies. France—which we name without invidious intent—would not forfeit a fraction of her growing naval strength if she scrapped her entire fleet of submarines, provided that corresponding action were taken by the other Powers. In fact, the simultaneous disappearance of all the submarines in the world would leave the current order of naval precedence precisely as it was before. Whether such a measure lies within the sphere of practical achievement remains to be seen. Judging from the semi-official statements which have been published, neither the United States, France nor Japan would be prepared to enter into negotiations for abolishing the submarine merely on the score of its liability to accident. Therefore, as we have suggested, the appeal for abolition should be made on the broader issue of international welfare and good-will. On that ground a more sympathetic response might be forthcoming.

Ground Gearing.

THERE are now in existence several designs of machines which are capable of grinding the teeth of gear wheels with an accuracy of a very high order. These machines are, broadly, of two types. In one, exemplified by the Maag, the action of which was described in our issue of March 18th, 1921, the finished ground profiles are generated by means of a pair of abrasive wheels. This type of machine is applicable only to the grinding of involute teeth. In the other class, typified by the machines which Mr. Orcutt uses at Birmingham, and which we described in our issue of July 29th, 1921, the ground surfaces are produced by the employment of a single abrasive wheel, the edge and flanks of which are formed to give the desired profile. In both types everything may be justly said to depend upon the accuracy with which the wear of the abrasive wheels is compensated for, so as to preserve the original form of the wheels and their setting relatively to the work. In the Maag machine a sensitive electrical system in conjunction with a diamond-pointed feeler is provided to move the two wheels away from each other in such a manner that at short intervals the constantly wearing cutting faces are re-set to the original distance apart. In the Orcutt machine the edge and flanks of the abrasive wheel just before the finishing cut is taken are trued up by three diamonds to the desired form. That form is controlled, so far as the flanks are concerned, by means of cams produced from a model profile eighteen times the size of the finished profile. Since the cam form is open to unrestricted choice, this system is applicable to any shape of tooth. By means of either of these types of machine it is possible to produce ground gear wheels, no dimension of which departs from the intended amount by more than three or four ten-thousandths of an inch. All things considered, such an achievement on a commercial basis is a remarkable development, and a performance of which those responsible may well be proud. But granting that such gear wheels with such accuracy are obtainable at a not too extravagant cost, practical engineers are naturally desirous of discovering what are their precise and distinctive merits and to what purposes they may advantageously be applied.

On these subjects the paper presented last Friday by Mr. Orcutt before the Institution of Mechanical Engineers gives a considerable amount, but by no means the whole, of the information desired. A study of that paper and the discussion which it evoked discloses the fact that the merits of the ground gear reside not in one outstanding property, but in a series of more or less minor properties, which, acting together, constitute an aggregate of much value in certain cases. Improvement of transmission efficiency, it can be said at once, is not one of the most important advantages resulting from the use of ground gears. Well-cut ordinary soft unground gear wheels may, when new, show an efficiency of over 99 per cent., while even a noisy pair of gears, giving rise to considerable vibration, may have an efficiency of between 98 and 99 per cent. The scope available for the improvement of efficiency by grinding the tooth faces is, therefore, in general, too small to render such improvement an object worthy of much endeavour. Much more important than any improvement in efficiency is the fact that the adoption of ground gears greatly extends the range of duties to which hardened gear wheels may be applied. The hardened unground gear has been extensively used for traction and other purposes, the effects of the distortion produced by the hardening process being tolerated for the sake of the extra resistance to wear obtained. For finer duties, such as in motor car gear-boxes or on machine tools, the unground hardened gear, with its errors of distortion, would be objectionable, and in motor cars to a very large extent hardened ground gears are now deemed indispensable, while in machine tools the demand for them would appear to be expanding. There is another aspect of this question of hardened gears, and to it Mr. Orcutt has rightly drawn attention. Hitherto, the material from which such wheels were made had to be selected largely with a view to its low distortion under the hardening process, and with but secondary attention to other desirable properties. If, however, the gears are to be ground the degree of distortion suffered during hardening is of minor importance, and consequently the range of materials open to our choice is considerably enlarged. As regards resistance to wear, there can be but little doubt that ground gears, hardened or not, are notably superior to unground gears. Even with the most refined "creep-cut" wheels, as Mr. Hyde, of the National Physical Laboratory, stated at last Friday's meeting examples have been found in which the whole load was transmitted through not more than 10 per cent. of the face width. The grinding process by eliminating the high spots goes far to overcome a fruitful cause of pitting and other forms of wear in gear wheels. Even without such irregularities, it seems certain that the smooth surface left by the abrasive wheel, as compared with that produced by the most perfect cutting tool, is a very material factor in the reduction of wear. Whilst it is well established that noise and vibration are reduced to the point of insignificance by the proper employment of ground gears, the position is complicated to an unknown extent by factors outside the control of the grinding process as such. A pair of wheels perfect in all dimensions and perfect as regards the nature of their contacting surfaces may still cause much noise and vibration by reason of faulty alignment of the shafts, original or developed by wear of the bearings. This is a point of the greatest importance on which Mr. Orcutt himself has upon several occasions spoken strongly. Many of our readers will recall a paper which he read some time ago before the Institution of Automobile Engineers, in which he roundly criticised the design and construction of gear-boxes. It is obviously futile to expect accurate gears to exhibit their qualities if they are not accurately mounted, are allowed to run in bearings having appreciable back-lash, or are employed in gear-boxes which distort under load. In mechanical engineering it always happens that the introduction of a refinement in one part leads to the development of accuracy in other associated parts. Events have already taken that course in motor cars as the result of the desire to benefit by the advantages of ground gears, and they will have to follow it in heavy traction work. For example, it is fruitless to expect to achieve that great desideratum of tramway vehicles—noiselessness—by the use of ground gears, if the bearings are not of a kind that will permit the gear to work for long periods without the development of mal-adjustment.

In the discussion Mr. Vernon raised another very interesting point. He suggested that the refined accuracy of a ground gear might be rendered unavailing by the deflection of the teeth under load. Calculation suggests that this deflection may, even at commonly used tooth pressures, amount to one ten-thousandth of an inch, that is to something comparable with the accuracy which the gear grinder seeks to achieve in his work. But even so, it would be unsound to argue that this fact removes the necessity for the high standard of accuracy aimed at in ground gears. On the contrary, if the amount of the deflection can be shown to be a cause of trouble, the cure for it is still more accurate grinding. We are far from feeling convinced that the deflection of the teeth is ever the source of any trouble in a gear wheel, but it may be pointed out that in the case of a pair of wheels running always in one direction, super-accurate grinding could provide a remedy—at least, so far as the Orcutt type of machine is concerned—by the production of teeth ground with a counter-distortion in the unloaded condition. A much more practical objection to the use of ground gears was raised by Mr. Troughton in his discussion of their employment for traction purposes. If, as is nearly always the case, the pinion wears out first, the alternative to scrapping both pinion and wheel simultaneously is to fit a new pinion to work with the partially worn wheel. Here, again, it is unsound to argue that the refined accuracy of the new pinion would be wasted. The effect of the wear on the wheel will be lessened by the use of an accurate new pinion. The ideal to aim at, as Mr. Troughton suggested, is to make the conditions such that the wheel and pinion will wear out together. So long as both are made of the same material, similarly treated, that ideal will remain unrealised. But by differentiating the materials and taking full advantage of the freedom of choice permitted by the adoption of the grinding process, it ought to be possible to make the economic life of the two elements equal. Finally, a purely commercial consideration which seems to have had, and still to be having, an important effect on retarding the adoption of ground gears has to be noted. Many manufacturers, it is said, have strong objections to placing themselves in the hands of outside firms specialising in gear grinding. In the motor industry the use of ground gears, we are led to believe, was for a time held up, and in the machine tool industry their use is still being held up, because of the inability of manufacturers to obtain the grinding machines with the object of carrying out the work in their own establishments. How far this contention is sound we are not quite certain. Mr. Orcutt holds that it is better for the work to be done by firms that lay themselves out for it particularly, and are able to train the highly expert staff which is necessary for the attainment of the finest results. In his view, the whole progress of gear grinding might be jeopardised by entrusting it to mechanics who were not qualified by adequate training to carry it out. The tendency of the day, certainly in motor car engineering, is towards specialisation, and there would seem to be a good deal in Mr. Orcutt's contention. At the same time, there are other makers of gear-grinding machines who do not hold this opinion, and who, we understand, are willing to sell machines. It is not within our sphere or our desire to criticise that policy.

The search for great refinements of manufacture is always fascinating to the engineer, but there are times and places in which it is not a commercial proposition. Gear grinding has, without doubt, the same limitations as other examples of super-accuracy; it cannot be employed economically everywhere. But that it has great possibilities cannot be doubted, and, if it has not already done so, it promises to become the standard practice in motor car engineering. Just as we have advanced from the crudely cut gears of twenty years ago to more accurately cut gears, and from soft gears to hardened gears, so we are now advancing towards a still higher degree of accuracy, and the possibility of using still more durable materials. The object sought by the motor car builder is first and foremost the attainment of quietness of running and the effort of the tooth grinder is to satisfy him. Silence is the quality which is put in the first place by all advocates of gear grinding, but there are probabilities that other qualities not less important will eventually be developed as the extension of the system proceeds. Mr. Tomlinson, of the National Physical Laboratory, showed on Friday night by very striking autographic records the difference between the regularity of velocity in cut and in ground gears. The latter presented a smooth figure in sharp contrast with the sharply indented figure of the former. Such diagrams are, alone, sufficient to suggest that injurious impact and vibration may be removed by great accuracy of tooth form and indexing, and encourage the belief

that ground gears will prove to have a longer life themselves and be less injurious to associated mechanism than less accurate gears.

The Status of Naval Engineers.

NEARLY twenty-three years have elapsed since the Selborne scheme, providing for the common entry and training of naval officers, was promulgated. Engineer officers were thereby admitted to the military branch of the service, with the same executive status as that of specialists in gunnery, torpedo, and navigation. The fundamental purpose of the scheme, of which Lord Fisher was the real author, was so to standardise the training of naval officers that they should be competent to undertake any form of duty which circumstances might require of them; in other words, the engineer was to be capable, if need be, not only of taking over the gunnery or torpedo work of the ship, but of assuming command of the ship itself. Whether this ideal could ever have been realised is still a subject for argument, though most authorities have always held the negative view. It never was attained in practice, for very shortly after the scheme was introduced there began a period of exceptional activity in the development of man-of-war mechanism and armament, and it speedily became apparent that efficiency in any one branch of the naval profession was only to be achieved by single-minded devotion to that particular line of duty. Circumstances thus conspired to maintain the system of specialisation. In theory, however, the principle of interchangeability persisted until 1918, in which year, following the adoption of new regulations, the majority of engineer officers renounced the option of reverting to deck duty after attaining between seven and a-half and nine years' seniority. Two years later another blow was struck at the original scheme by an Admiralty decree that officers selected for the engineering branch when sub-lieutenants would, after taking the advanced engineering courses, be ranked permanently as engineer officers, and never return to deck duties.

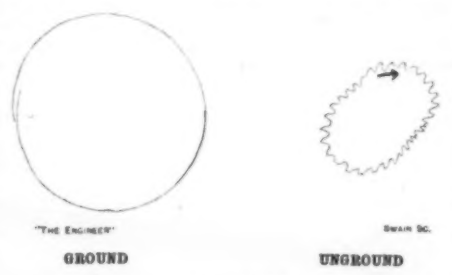
The First Lord's Memorandum of 1920 declared it to be essential that the majority of officers in the engineering department should be "whole-time" officers, having regard to the definite distinction that existed, both as to knowledge and professional training, "between those who are to be trained in the science of naval war and strategical and tactical methods of fighting, and those who are to deal with the upkeep and maintenance of engineering and mechanical appliances necessitated by the complex machinery and weapons of modern war. Each side requires a special study, and for this reason final separation of the branches is essential." To the discerning mind these truths were doubtless as patent in 1902 as they had become to the naval authorities eighteen years later. As it was, the announcement of 1920 caused scarcely a ripple of interest in naval engineering circles, where it was regarded as no more than an official recognition of what had already become the established practice. The one really admirable feature of the Selborne scheme, common entry for all officers and common training in the earliest years of initiation into the atmosphere and traditions of a great service, has happily survived, and will, we hope, never be abandoned. Now, however, a new and somewhat surprising decision has been reached by the Admiralty. A Fleet Order issued on Saturday last announces that naval engineer officers are no longer to hold the military rank to which they were admitted by the Selborne scheme. From now on they are to be classed with other non-executive branches, such as medical, dental, account, and instructor officers, and be, like them, ineligible for military command. Furthermore, the arrangement by which certain (E) officers have hitherto been entitled to revert from engineering to executive duties is to be cancelled, and promotion from Lieut.-Commander (E) to Commander (E) is henceforth to be in competition with engineer and not with executive officers. In future editions of the Navy List officers qualifying for or engaged in engineering duties are to be grouped in separate seniority lists, in the same section with older engineer officers. A further ruling is that the distinguishing purple badge of the engineering branch is now to be worn by all engineer officers of and above the rank of midshipman. Formal expression is thus to be given to the final and complete separation of engineer from executive officers.

This action seems to us to be at variance with the spirit of the Selborne scheme, which sought, *inter alia*, to remedy the anomalous position in which the engineer officers of the Navy had previously been placed. In any case, while the practical consequences of the new Order may be of no great moment to the officers concerned—a point which cannot be decided until further details are vouchsafed—we think it desirable that the Admiralty should state its reasons for taking the step in question. In former years it was customary for the naval authorities, when announcing any important departure from existing policy, to publish the grounds upon which their decision rested. The Selborne scheme itself, and the principal modifications it subsequently underwent, were explained in lengthy memoranda with a frankness that left little to be desired. This was but right and proper, for the Navy is a national institution, the welfare of which is a matter of legitimate concern to the public. We therefore think that the country is entitled to learn why it has become necessary to deprive naval engineer officers of military status and cause them to revert to the invidious position they held in the old days, when the engineering branch, though already vital to the naval organisation, had not attained its present commanding importance. It is hard to believe that any measure calculated to detract from the prestige of the naval engineer officer is in the best interests of the service as a whole. For this reason the deprivation of military rank seems to us a retrograde move, strangely out of keeping with the progressive policy on which the present Board of Admiralty prides itself.

Institution of Mechanical Engineers.

THE paper presented on Friday night by Mr. H. F. L. Orcutt, of Birmingham, before the Institution of Mechanical Engineers, entitled "Characteristics and Uses of Ground Gears," called forth a good attendance of members and visitors, and led to a satisfactory discussion. Elsewhere in this issue we begin a reprint of the paper in full. In opening the discussion, the president, Sir Vincent L. Raven, emphasised the precise words in the title of the paper by way of a hint, presumably, to those present not to dwell on the merits of particular commercial processes for the production of ground gears or of particular machines used in their manufacture.

Mr. G. A. Tomlinson, of the National Physical Laboratory, invited to open the discussion, stated that following the examination of many gears during the past two years he was in a position to agree with Mr. Orcutt regarding the accuracy obtained by grinding. The order of accuracy was similar to that found on ground shafts as compared with turned shafts.



GROUND UNGROUND

Good ground gears were usually found to be accurate to three or four ten-thousandths of an inch on all dimensions. In order to demonstrate the uniformity of the motion transmitted by ground gears, he showed two slides representing the records obtained on a machine—particulars of which were not given—by a ground gear and a hardened unground gear. The records, reproduced herewith, were such that a perfect gear would give a circle or a fairly close spiral. Departures from a smooth circular curve in the form of radial displacements indicated variations of velocity ratio. At the peaks of the curve given by the unground gear the accelerations represented were very great, of the order probably of 20,000ft. per second per second.

Professor E. G. Coker briefly indicated some of the results he had obtained by using the photo-elastic method to investigate the tooth action and distribution of pressure and stresses in engaging gear wheels. He found that the stresses were very high, not only at the area of contact between the teeth but at their roots. These experiments were conducted statically, but other investigators were now studying the subject with the gear models running, the illumination being interrupted to suit the speed of rotation. Professor Coker also showed slides to demonstrate the stresses induced in gears by the forcing of the wheels on to their shafts and also the complicated distribution of stress caused by the presence of a keyway.

Mr. P. V. Vernon dwelt on the author's remarks regarding the use of ground gears by machine tool makers. It was not strictly accurate, Mr. Vernon contended, to say that machine tool makers had as yet made no use of ground gears. Many machine tool makers had experimented with them and had adopted them to a limited extent, but the gears were difficult to obtain, particularly in the larger sizes required in a machine tool, and machine tool makers did not like placing their orders for ground gears with outside firms. It was essential, he held, that machine tool makers and other engineers should be supplied with gear grinding machines, in order that the production of ground gears might be completely under their own command. On the question of accuracy, he thought it was very desirable to regard gears as means of transmitting power and not simply as means of transmitting motion. Under load each tooth became a cantilever, and was therefore bound to deflect. The actually effective force was consequently not that of a perfect involute accurate to three or even one ten-thousandth of an inch. The character of the engaging surfaces was, he continued, almost as important as their mathematical form. Even if ground gears were "run in" with an abrasive, they would, he felt certain, be improved as a result of the polish given to the surfaces. In cutting gears for difficult cases in which it was hard to get quietness and smooth action, it was found possible to get better results if contact were made to occur when the teeth were receding from the centre line instead of being made to occur on both sides of that line.

Mr. H. I. Brackenbury remarked that helical gears were now being made, on the creep cut principle, with much less inaccuracy than was found in ground gears, but even so noise had not disappeared. Noise, he thought with Mr. Vernon, was caused by deflection under load and was probably produced by the teeth when they were just coming into contact. The alignment of gear shafts was a very important factor in securing satisfactory action. Full advantage could not be obtained from the most accurately ground gears unless the shafts were properly aligned. Concluding, he expressed his affection for the old millwright's wooden cog made with a chisel and mallet. It might have been rough, but for a long time it was the only form of silent gearing available.

Lieutenant-Colonel A. E. Davidson paid a tribute to the pioneer work which had been done by Mr. Orcutt in connection with ground gears. That work, he said, came to the notice of the War Office about 1912, when considerable trouble was experienced with noisy gears and wear on splined shafts. It was hoped that the system of grinding advocated by Mr. Orcutt would have been helpful in the solution of these problems, especially as splined shafts might be dealt with in the same way as gearing. Unfortunately it was not possible for Mr. Orcutt to supply the necessary machines which would have enabled lorry builders to manufacture ground gears for themselves, and they were disinclined to give out extensive contracts to outside firms for fear of delays in delivery. In 1913, when the specification for the subsidy lorry was being drawn up, it was not possible to insert a clause specifying ground gears because the machines were not available for manufacturing such gears in the makers' works. Makers had, however, been converted to ground gears, with the result silent running had largely been obtained. He agreed with the author in his emphasis upon accuracy, correct alignment, and well-designed wheels. Good and well ground gears could easily be spoilt by badly cut keyways and by being forced on shafts, thereby causing incorrect alignment.

Mr. H. J. Troughton dealt with the use of ground gears in the traction industry, particularly on tramway cars. There was a commercial aspect to set against considerations of accuracy. Hardened unground gears were from 25 to 50 per cent. more expensive than soft gears, but their life was three or four times as great and therefore the extra service rendered was out of all proportion to the extra cost. Hardened underground gears were giving quite good results as regarded absence of noise. The wear suffered by such gears was found to be about 0·02in. per 100,000 miles, and their life from ten to fifteen years. The accuracy of alignment of the gear shafts depended upon the wear of the bearings. From that point of view ground gears were unsuited to white metal bearings. Practice was, however, improving, and it was now possible to keep shafts in alignment for longer periods than formerly, with the result that the field for the use of gears of increased accuracy was widening. In that connection it was worthy of note that the more accurate the gears were the better was the quality of lubricant that could be employed. The problem of gear renewal affected the question of ground *versus* unground gears. The gears might be highly accurate to begin with, but after a few years, time the pinion would be badly worn. It was then necessary to decide whether a new pinion should be put in to work with the partially worn wheel, in which case much of the value of the initial accuracy would disappear, or whether both wheel and pinion should be scrapped. It would be very desirable if it could possibly be arranged that the pinion and the wheel should wear out together.

Mr. J. H. Hyde, of the National Physical Laboratory, expressed surprise at the accuracy alleged to be obtained in gear-cutting machines. His own experience with helical gears cut by the creep method showed that there were periodic high spots on the teeth faces. Those spots carried the load, and in some cases the whole load was borne on not more than

10 per cent. of the face width. As a result, disintegration and pitting took place. Turning to Mr. Orcutt's model, he said that he did not agree that it showed the absence of rolling. There was quite a considerable amount of rolling, and in its presence an explanation of pitting could be found. When the rolling action was a maximum, the lubricating oil was squeezed out and thereafter the contact was made between practically unlubricated surfaces. From that point of view viscosity was to be avoided in the lubricating oil for work had to be done in squeezing it out and consequently the efficiency was affected. At the National Physical Laboratory experiments would shortly be begun on the effect upon efficiency of the common errors of practice in the manufacture of gears. It was hoped that it would be possible to state what kind of error was the most important, and how much of it could be allowed in gears for a particular duty.

Mr. L. A. Legros asked Mr. Orcutt to state what were the usual errors found in the division of the teeth of gear wheels and what were the errors in the form of the teeth produced by backlash. Some generating machines, he continued, developed teeth that were not of the same form on both sides. Two wheels could therefore be mated in four different ways. It was sometimes found that three out of the four ways were unsatisfactory, while the fourth gave noiseless running even with unground teeth. Speed, he held, was one of the biggest factors in the production of noise Noise had its origin in irregularity of velocity. Referring to Mr. Brackenbury's remarks regarding wooden cogs, he recalled some wheels of that description at a cement mill which involved an expenditure of over £100 per year per pair for re-cogging. Double helical wheels were installed in their stead at a cost of £200, and paid for themselves in the course of two years.

Mr. Orcutt, in the course of his reply to the discussion, expressed a desire to see the experiments referred to by Professor Coker conducted with very accurate steel or iron gears instead of with celluloid models. Referring to Mr. Vernon's remarks, he said he thought that machine tool makers would sooner or later adopt ground gears. If a gear wheel lost its accuracy under load by deflection, the remedy was to make the teeth stronger or alternatively not to overload the gear. Most motor car gears were overloaded, and he did not blame them for making a noise. He had tried running in his gears with an abrasive, but had not obtained any good result. On the question of placing the grinding machines on the market, he said that for the present such a step was out of the question, but that later on, when development work was more or less completed, they would no doubt take it. For traffic work such as mentioned by Mr. Troughton, the use of accurate gears would at least permit the discovery of those troubles that were not due to the gears. Mr. Hyde's reference to the concentration of load on the high spots of inaccurate teeth indicated a factor that was bound to cause trouble. That trouble, however, could not arise if the gears were ground.

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The Public Works, Roads and Transport Exhibition.

No. I.

THE Exhibition, which is held in connection and concurrently with the Public Works, Roads and Transport Congress, was opened at the Royal Agricultural Hall, Islington, on Thursday of last week, and terminated yesterday. It was in several respects noteworthy. For one thing, practically every stand was complete on the opening day, which is not usual in exhibitions; and for another, there was in evidence a general feeling, if not, perhaps, of actual affluence, at any rate of optimism. There was certainly no sign that the many trades represented either directly or indirectly at the Exhibition are in a bad way; on the contrary. Matters have clearly not been allowed to stand still since the immediate forerunner of this Exhibition was held two years ago. Previously-existing types of machinery have been improved upon and new types have been evolved. In short,

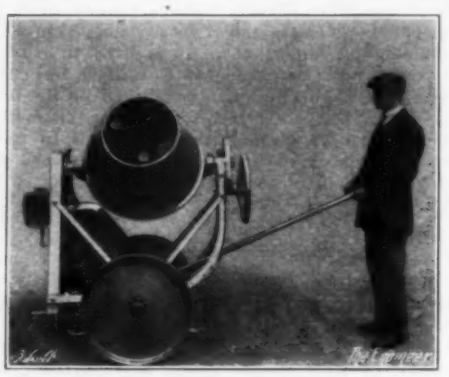


FIG. 5—"FEATHERWEIGHT" CONCRETE MIXER—RANSOME

the general impression remaining in the mind of the visitor when he left the building was that if the numerous exhibitors were not actually experiencing a period of marked prosperity, they were confidently looking forward to doing so in the immediate future. Part of the activity of which there were pleasing signs is doubtless due to the facts (*a*) that for some time now, extensive road constructional and reconditioning operations have been in progress throughout the country, and (*b*) that plastic materials of one kind and another are being employed to a much greater extent than formerly in the formation and surfacing of our highways; in fact, as we shall show subsequently, one of the features of the Exhibition was the number of self-contained machines for the production of asphaltic macadam and similar mixtures. It was not, however, only in connection with machinery, appliances and materials used for road-making that signs of progress were observable. Improvements in quite a number of machines for making concrete blocks, &c., for house building were noticeable and there were several interesting novelties in the way of tractors, &c.

In placing before our readers the result of our inspections we shall make no attempt to classify the various exhibits, nor, needless to say, to make any sort of comparison between exhibits of a similar nature. We shall simply refer haphazard to various stands, and, because one may be mentioned before the other, it must not be taken that we suggest that it is superior to any other.

With so much preface, then, we may proceed to give some account of the exhibits. On the stand of the Ransome Machinery Company (1920), Ltd., of Windsor House, 46, Queen Victoria-street, London, S.W. 1, there were several exhibits which attracted our attention. First of all there was a power-driven concrete block-making machine which is entirely automatic in its action and which, it is said, can turn out ten blocks measuring 18in. by 9in. by 9in., or their equivalent in smaller blocks, per minute, and only requires a 4 horse-power motor to drive it. The machine, which is known as the "R.V. Blockmaker," comprises a circular horizontal table furnished with four block moulding pockets arranged symmetrically at equal distances apart. This table is revolved a quarter of a revolution at a time so that the openings or pockets may take up appointed positions. In the first position the necessary pallet, fillets, &c., are fitted in the mould. In the next position the mould is brought under the delivery of a feed hopper which is furnished with a mechanically-operated agitator that keeps the concrete of which the blocks are being made constantly stirred. In the third position the mould is brought immediately underneath a ram which is moved vertically up and down and which, when down, exerts a pressure of 8 tons on the concrete in the mould. In the final position the pressed block is automatically forced up till its bottom is on a level with the top of the table, so that it can be lifted and taken away. This cycle of operations takes six seconds, and it is repeated continuously. The various motions are all actuated by the one motor, and the only things done by hand are the placing of the pallets in the mould, keeping the feeding hopper supplied, and removing the finished blocks.

We were shown on this stand, too, a contrivance which has just been added to the firm's concrete mixers by which, it is claimed, that the work of mixing is better done and all tendency of the charge to "ball" or pack is eliminated. The Ransome mixer has curved blades attached to the interior of the mixing drum, which, as the drum is revolved, turn the "mix" over. The new contrivance, which is known as the "Positive," consists of a further curved blade which is attached to the top of the post on which the drum revolves and is led down towards, though it does not quite reach the bottom of the drum, the arrangement being such that when a batch is fed into the drum the blade is covered by the materials to be mixed. This additional blade remains fixed, since the post to which it is fixed does not revolve, and the mix, in being forced past it as the drum is revolved, is thoroughly turned over and thrown towards the blades attached to the drum.

A handy little mixer, which has been specially designed for contractors or builders in a small way of business, is shown in Fig. 5. It is known as the Ransome "Featherweight" tilting drum mixer, and it has a batch capacity of 4 cubic feet. As will be observed, it is carried on road wheels and is furnished with a handle by which it can be wheeled about from place to place by one man. It is operated by a 1½ horse-power petrol engine.

An imposing exhibit on the Ransome stand was a mixer fitted with a boom attachment for placing concrete at any point on a road 30ft. wide. The boom, a rolled steel joist, is supported at each end by an upright frame carried on wheels which run on rails laid temporarily on each side of the roadway being

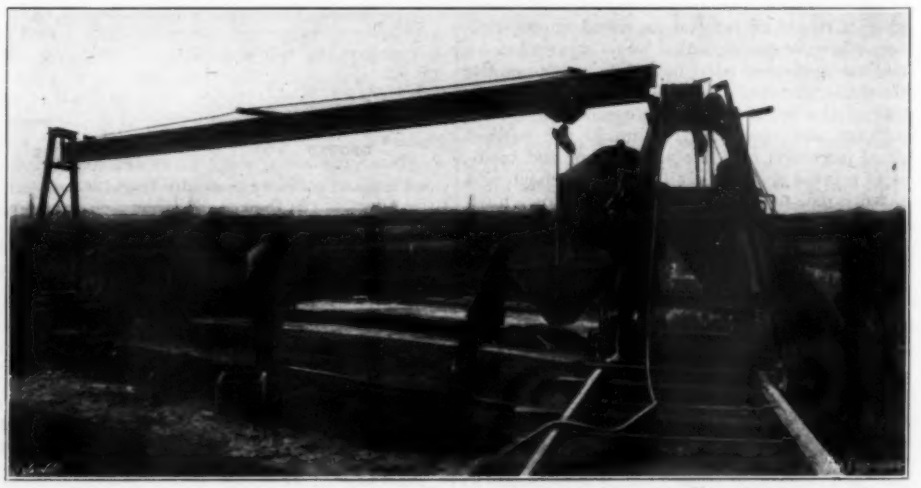


FIG. 6—"WELTERWEIGHT" MIXER WITH BOOM ATTACHMENT FOR ROAD MAKING—RANSOME

dealt with. The mixer—in this case one of the firm's "Welterweight" machines, which has a batch capacity of 12 cubic feet—is attached to one of the side frames and it delivers the mixed concrete into a tilting skip depending from a trolley which can be run backwards and forwards along the boom. The combined plant is shown in actual operation in Fig. 6.

We turn now to a machine of an entirely different character—a neat little 10 horse-power petrol locomotive, which was made by the Kent Construction and Engineering Company, Ltd., of Ashford, Kent, and exhibited by Honeywill Brothers, Ltd., of Ashford, Kent, and 79, Mark-lane, London, E.C. 3, the sole selling agents. It is known as the "Planet"

—see Fig. 7—and is a particularly compact and handy looking little engine. It is propelled by a four-cylinder engine, 69 mm. diameter by 100 mm. stroke, made by Messrs. Dorman, of Stafford, which is water cooled by a radiator, and forced lubricated. That the engine is four-cylindered, is put forward as one of the special features of the locomotive. The transmission is through a foot-operated clutch—which is housed in a casing integral with the engine crank case—to a two-speed gear-box furnished with bevel reversing gear of the usual type, thence by roller chains to a central countershaft, and, finally, to each of the two axles. The wheels are 15in. diameter on the tread. Braking is effected by means of a hand-operated Ferodo-lined band brake, that works on a drum fixed on the central countershaft, in consequence of which arrangement the chains driving from that shaft to the axles have been made unusually strong. Sanding gear, with sand valves of the gate type, is fitted to each wheel, and the axle-boxes are of the floating type, with adjustable spring gear to permit of taking up the wear of the driving chains, and to relieve the latter from shocks. The locomotive has central cast steel buffer couplings, with

FIG. 7—10 H.P. "PLANET" PETROL LOCOMOTIVE

double-acting volute springs, the height from the rail being 13in. The gauge of the engine exhibited was 2ft.; but the gauge can be made anything from 15in. to 2ft. 6in., and it is claimed for it that it can run on light and roughly laid track and that, on gradients up to 1 in 40, it is sufficiently powerful to haul the number of skips usually employed in contractors' operations. With the engine running at 1000 revolutions per minute and a locomotive speed of 3·3 miles per hour, the tractive effort is given as being 850 lb., while the haulage capacity—frictional resistance being taken at 25 lb. per ton—varies from 33 tons on the level to 4½ tons on a 5 per cent. gradient. With a locomotive speed of 6·7 miles per hour, the tractive effort becomes 425 lb., and the haulage capacity varies from 16 tons on the level to 1½ tons on a 5 per cent. gradient. The engine can, it is said, be safely run at 1500 revolutions per minute, which would give speeds of some 5 and 10 miles per hour respectively, with approximately the same tractive efforts as those just mentioned. The weight of the locomotive in running order is 1¾ tons and the capacity of the petrol tank is 8 gallons. The length over the buffers is 8ft. 5in., the overall width 4ft., and the overall height 4ft. 4in. The wheel base is 4ft., and the minimum rail clearance 2¾in. Alongside this small engine was a larger locomotive, also for 2ft. gauge, though we understand that it can be made to operate on gauges up to 3ft. 6in., which is fitted with a Dorman engine of 20 horse-power. It is stated that this locomotive can haul a maximum of 50 tons on the level or 7 tons up a gradient of 1 in 20.

Barford and Perkins, Ltd., of Peterborough, have for a number of years enjoyed the reputation of designing and building first-class motor rollers for various purposes, and on this occasion they exhibited several different types, varying in weight from 35 cwt. to 12 tons. Most of these machines were of standard pattern, or, at any rate, differed only in detail from similar machines that have been exhibited before, but one of them—known as the Q, or quick-reverse, type—embodied some distinctly novel points. It is illustrated in Figs. 8 and 9, and it is a tandem water-ballast machine, specially designed for rolling asphalt road surfaces. Two sizes of it are made, the particular size exhibited being Q 6, which has a weight in working order, without water ballast, of 6 tons

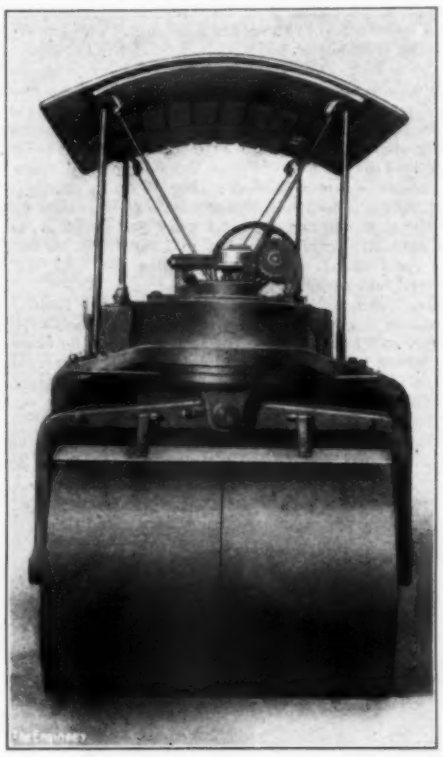


FIG. 9—FRONT VIEW OF BARFORD & PERKINS ROLLER

4 cwt. It can carry water ballast to the weight of 1 ton 16 cwt., so that the total weight in working order with water ballast becomes 8 tons. The other size, known as Q 7, has a total weight, empty, of 7 tons 1 cwt., or, with water ballast, 8 tons 14 cwt.

Both these engines are noteworthy in being fitted with a patented quick-reverse gear, which consists of two plate clutches actuated by the driver's feet. The arrangement gives, it is claimed, the smooth reverse, which is so essential for successful work, and entirely obviates the jerk which is experienced with some forms of clutch. The pressure on these clutches is derived from a single spring on the outside of the gear-box, which acts through a disc crank, which, in turn, is keyed to a quick-threaded screw in the gear-box. Fitted at the opposite end of this screw is a small sprocket wheel which is connected by means of a chain and levers to the foot levers, the arrangement being such that when one pedal is depressed the other is raised. On pressing one pedal pressure is brought to bear on the "forward" clutch, while, on pressing the other pedal, pressure is brought to bear on the reverse clutch, so that the direction of the roller is reversed by simply pressing one pedal or the other. The clutches, which are enclosed in the gear-box, consist of dual plate clutches, with Ferodo linings. They are actuated by a sleeve, with ball-thrust washers, which slides on the clutch spindle and apply the pressure through small levers, which, in turn, actuate plungers and apply the spring load to the clamping plates. The clutch casing runs in ball and roller bearings, the thrust being taken by ball journal bearings. This arrangement is necessary owing to the relatively high difference of speed between the clutches when they are at work, for when one clutch is running at the engine speed of 1000 revolutions per minute, the other clutch is running in the opposite direction at a like speed, the relative speed difference being, therefore, 2000 revolutions per minute.

Another feature of these rollers is that they are fitted with a power steering gear, which can, it is stated, turn the front rollers from side to side in a few seconds, even when the roller is at a standstill, the actual time occupied in moving from centre to extreme position being only 4 sec. The mechanism consists of two small metal cone clutches, which derive their power from the clutch spindle in the main gear-box. The drive is transmitted by a roller chain to the steering hand wheel spindle, and operates from

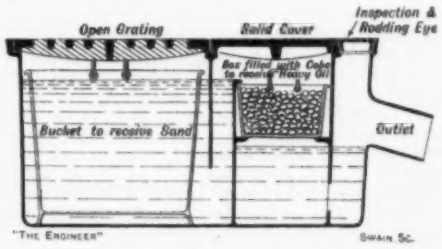


FIG. 10—SAND AND OIL TRAP—FARRER

that point through the standard steering arrangement. The clutches are controlled by a small lever handily placed for the driver, and only a slight pressure is necessary. This pressure is exerted in the direction in which it is required to turn—to left or to right—so that there may be no mistake or confusion in steering, and, when the hand is removed the lever automatically returns to the neutral position. There is a safety gear which automatically stops the steering gear if the rollers are locked round beyond a safe angle. The thrust on the clutches is taken by ball thrust washers and the bevel gears are enclosed and run in oil. The whole device appeared to us to be extremely simple, and we are informed that it does not require any attention beyond occasional oiling. In addition to it, there is the usual steering wheel for use should anything go wrong with the power mechanism. As will be seen from Fig. 8, the roller is of distinctly smart appearance, while Fig. 9 shows the small amount of overhang of the frame beyond the edge of the rollers, so that the rollers can be used close up against a kerb.

A quite simple device which apparently works exceedingly well and gets over a considerable difficulty, was shown by William E. Farrer, Ltd., of Star Works, Heath Mill-lane, Birmingham, and 39, Victoria-street, Westminster. It is shown in Fig. 10, and is a sand and oil trap which is specially designed for use in motor garages. As will be observed, the trap is divided into separate chambers by means of partitions. The left-hand chamber is provided with an open grating, through which the water that has been sprayed on to cars in the garage to clean them, and which, therefore, may contain both dirt and oil, finds its way. This chamber contains a bucket into which the whole of the water first falls. The discharge from the bucket into the body of the chamber is over the rim of the bucket, so that sand and other

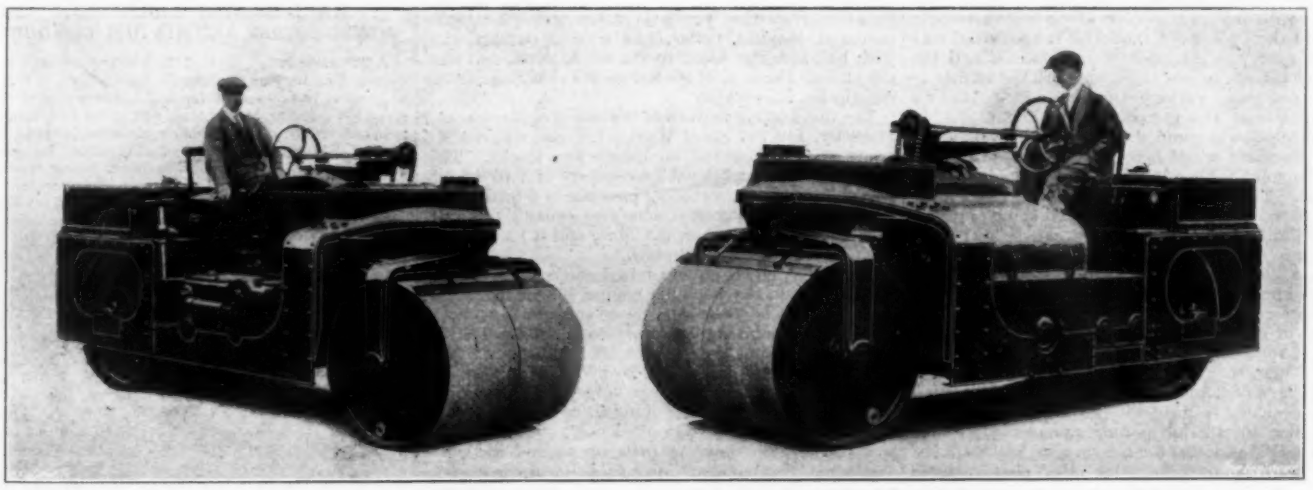


FIG. 8—QUICK-REVERSE TANDEM WATER-BALLAST MOTOR ROLLER—BARFORD AND PERKINS

heavy materials are deposited in the bucket, and are not carried over by the flow of the water into the next chamber, as, of course, the oil is. The second chamber is formed with a ledge just above overflow level, and the whole of the aperture formed by this ledge can be closed by resting on it a metal box with a perforated bottom, which box is filled with fairly finely broken coke. The water flowing over the partition between the chambers has to pass through the coke before it can reach the outlet, and it is stated that the coke arrests the oil and prevents it passing away with the discharge. The makers do not, of course, claim that the trap will intercept petrol, for petrol is a spirit and very different from lubricating oil; but they do claim that it effectually prevents the passage of sand, grit and lubricating oil, and that it meets a want which every motor car owner or garage proprietor feels. The bucket and coke box are, of course, removed at intervals for cleaning. The trap is of exceptionally heavy weight, some 6 cwt., we understand, it having been specially stoutly constructed so that the heaviest motor vehicle may rest on it without doing the grating or cover any injury. A particular point of which Messrs. Farrer made mention is that when this trap is used, various Authorities will allow the garage drains to be connected to the sewers, which, they inform us, is often refused under other circumstances. We may add that the trap measures at ground level 2ft. 9in. long by 1ft. 9in. wide, with a projection of 4in. at one end for an inspection and rodding eye above the outlet, and that its overall depth is 18in.

The Lacre Motor Car Company, Ltd., of 78, York-road, King's Cross, London, N. 1, and Letchworth, Herts., was exhibiting a tipping wagon of the form shown in Fig. 1, page 582. It is known as the "gravity-type," and no engine power is required to operate the tipping mechanism, the tipping being brought about with wonderful celerity by means of quite a small handle. We are informed that a full load can be tipped and the body brought again to the horizontal in 30 sec., and we can well believe it, though we did not see the actual operation performed, for there was no load available. The makers claim that the tipping speed compares favourably with that attained with hydraulic and other power-tipping gears, and they point out that with it the initial cost of power gear, the attendant complications and the cost of maintenance are eliminated. This vehicle is made in six sizes, varying from 30 cwt. to 5 tons load capacities. The standard body is 8ft. 6in. in length, 5ft. 8in. wide, and the sides are 1ft. 8in. deep, and the standard wheel base is 10ft. 6in. The tires are of the solid rubber band type—single front and twin rear. The gearing gives three forward speeds and one reverse, the top forward speed being approximately 16 miles per hour.

The Lacre Company also exhibited motor sweepers of various kinds, one, for use in garages and large works, looking specially attractive.

An interesting feature of the exhibit of Robey and Co., Ltd., of Lincoln, was the 3-ton petrol "Clearside Tandem" road roller, which has recently been put upon the market. This roller, which is illustrated in Fig. 3, page 582, and in Fig. 11 herewith, has been specially designed to meet the increasing demand for a light roller suitable for making and repairing roads and footpaths, and also for use on golf links, cricket grounds, race-courses, &c. Its chief characteristic is the "clearside" arrangement, which permits the rolls to work close up to walls, trees and other obstructions. This peculiarity, which is claimed by the makers not to be possessed by any other make of tandem roller, is well illustrated in Fig. 11, which is a view taken looking down on the top of the machine. This "clearside" for rolling is obtained by carrying the front axle in a single arm fork, made of forged steel, which is attached to a master pin supported by the front head bracket. It also transmits the steerage which is operated by worm and quadrant. The rear axle is also only supported on one side, and it is held by the main gear-box casing. The main frame is formed by bolting together the front head bracket and the gear-box casing, which are both made of special cast steel to give them ample strength for the work they have to do. The front and hind rollers, which are of cast iron, are fitted with phosphor bronze bushes, and the front rollers are made in three sections to facilitate steering. A ball race is introduced between the front master pin and the head bracket to reduce friction to a minimum. Adjustable scrapers are fitted to both front and hind rollers, which are each 3ft. in diameter and 3ft. wide.

The engine, which is of the four-cylinder high-speed petrol type, giving 12 brake horse-power, is fitted with a governor, a Zenith carburetter and a B.T.H. magneto. A radiator of the thermo-syphon type is fitted on the top of the main gear-box. The engine is coupled through a flexible joint to the main shaft of the gear-box. On this main shaft there is double-cone clutch which drives, by means of silent chain and spur gearing, the two-speed gear on the countershaft by means of sliding pinions, the mechanism being operated by a hand lever outside the gear-box. The final drive from the gear box to the hind roller is by means of a stud pinion acting on an internal spur ring, which is fastened to the inside of the roller rim. All the shafts in the gear-box have ball bearings, and the gears are totally enclosed and run in an oil bath. The road speeds are 2 and 4 miles per hour, both forward and reverse.

The quick-reverse gear is operated by hand by means of a lever, which is within easy reach of the driver, and is coupled to the inner disc of the clutch, and which is free to engage in either cone clutch ring. These clutch rings, in turn, drive the countershaft by means of either silent chain or spur gearing, so as to give forward or reverse travel respectively.

The overall length of this roller is 9ft. 1in., the overall width 4ft. and the overall height 5ft. 9in. The

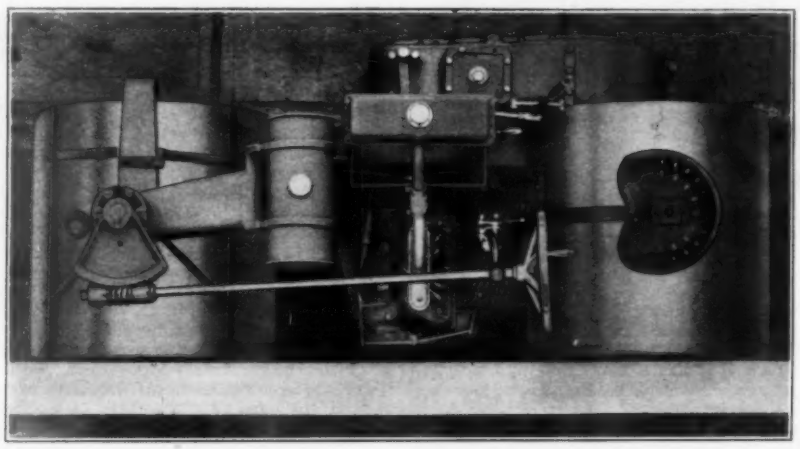


FIG. 11—VIEW LOOKING DOWN ON A "CLEAR-SIDE" ROLLER—ROBEY

capacity of the petrol tank is four and a half gallons.

Messrs. Robey also exhibited their latest model 6–7-ton steam tipping wagon, which is illustrated in Fig. 2, page 582. This vehicle is fitted with hydraulically-operated tipping gear, which is arranged to discharge the load on either side or at the end. Beyond the fact that the wagon is fitted with the firm's patented stayless boiler, has a compound engine with ball bearings fitted to the crank shaft, and that the chassis frame is of special nickel steel, no further description is necessary.

The dominating feature of the stand of Ruston and Hornsby, Ltd., of Sheaf Works, Lincoln, was a No. 6 crane navvy mounted on caterpillar tracks. This machine has a bucket with a capacity of 7 to 8 cubic yards, and can put a cutting pressure of 6 tons on the teeth. The maximum discharging centres are 24ft. It is not an entirely new machine, and it has already been described in our columns.

A novelty, however, which had not been previously exhibited was the portable engine shown in Fig. 4, page 582. It is designated by its makers Class E.P., and the particular engine exhibited was Mark 4, E.P., the other sizes in the same series being 2, 3 and 5 E.P. Mark 4 E.P. engine is rated to give 20 brake horse-power on fuel oil and 22 brake horse-power on refined oil at 360 revolutions per minute, and the engine is specially designed to work efficiently, without alteration, on a wide range of fuels up to and including standard Diesel engine oil. It is of the medium-pressure, hot-bulb, four-stroke cycle type. Governing is effected by means of a governor which controls a mechanically operated by-pass valve attached to the pump, which regulates the supply of oil fuel according to the load on the engine. It is of the high-speed, spring-loaded type, and is driven from the cam shaft by machine-cut gear wheels. Cooling is effected, as also in sizes 2 and 3 E.P., by means of a hopper, though in size 5 E.P., which develops from 25 to 28 brake horse-power, the circulating water is cooled by passing it through a fan-cooled radiator.

The engine is described as being easy to start by hand, the vaporiser being small and only taking a short time to heat before starting up is possible. The vaporiser is heated by a compressed oil vapour lamp, which is, of course, not required when the engine is running. The compression employed is low, and we understand that, with suitable fuel oils, consumptions of from 0·5 lb. to 0·6 lb. per brake horse-power are obtained, according to the size of the engine.

The general construction of the engine and its carriage are evident from the illustration, and we need only add that there is provision for attaching a pulley to either of the fly-wheels. The pulleys for the 4 E P size are 22in. in diameter, and 7in. on the face. The overall length and width of the size 4 E.P. engine are 10ft. 9in. by 6ft. 3in. The hind road wheels are 39in. by 6in., and the fore wheels 30in. by 5in. The gross weight is 59 cwt.

SIXTY YEARS AGO.

EXCEPT perhaps America, so we wrote in our issue of November 24th, 1865, no country surpassed our own in the record of lives lost and property damaged through disasters ironically termed accidents. Our Government was negligent in the matter, and our laws and Acts were piecemeal and continually failed to meet new circumstances as they arose. Legal proceedings completely failed when scientific questions had to be dealt with, and parliamentary committees on technical legislation were merely dull and long-drawn farces. In a patent case it frequently happened that long before its conclusion the unhappy jury became quite befogged as to all the questions at issue, and some complicated cases had even had to be thrown up because of the utter inability of the court to understand them. In an inquiry involving scientific or engineering matters the average coroner and his jury were placed by the law in such a position that an abortion of justice generally resulted. The coroner had no power to summon and pay for professional assistance, other than that of medical men. The only scientific witnesses heard at an inquest involving engineering or similar technical questions were those whose interest it might be to hush up the cause of the disaster. As an instance we quoted the case of an accident at the Great Northern Railway station in which life was lost as a result of a sudden failure of some arches. At the request of the jury, the coroner called upon Mr. Kerr, Professor of Architecture at King's College, to examine the ruins and give evidence. For his services Mr. Kerr was given a fee of two guineas by the coroner. Even this small fee was disallowed by the bench of magistrates, and the coroner had to bear it out of his own pocket. Only in the case of a railway disaster could the coroner have the assistance of unprejudiced engineering witnesses. A Government inspector generally reported upon such mishaps, and attended the inquiry for the purpose of providing impartial expert evidence. The blunders and omissions of the law in this matter called urgently for amendment, and we suggested that a beginning might be made by extending the procedure in case of a railway disaster to that followed in the case of a boiler explosion. . . . What form of means for intercommunication on trains a correspondent, "C. J. Z.," had submitted to our notice, it is now impossible to say, except that it involved certain inclined planes and a roundabout method of signalling. Our answer to him is, however, on record in the issue mentioned above. We had received, we said, dozens of such schemes, each, if possible, more impracticable than the last. Time and again we had written on the subject, apparently to no purpose. When would our correspondents learn to spare us? There were the railway companies—why not afflict them? They were able to bear it—we were not. With every desire to act courteously, we had decided to take not the slightest notice of any letter giving a scheme of intercommunication in trains, for at least six months.

HARD-DRAWN ALUMINIUM AND STEEL-CORED ALUMINIUM CONDUCTORS.

A SPECIFICATION, No. 215, 1925, just issued by the British Engineering Standards Association, is very similar in general lines to that for hard-drawn copper solid and stranded circular conductors, and gives full details of the number of strands, weight, resistance, tensile strength, &c., of the standard sizes of aluminium for steel-cored aluminium conductors for overhead power transmission. The standard sizes are based upon the standard sizes of hard-drawn copper conductors, there being an aluminium or steel-cored aluminium conductor of equivalent resistance to each primary standard size given in B.E.S.A. publication 125, 1924. Some useful notes are given, explaining how the values in the various tables have been arrived at.

An interesting feature of the specification is an appendix, giving the British standards of resistance of aluminium for electrical conductors. These standards have been agreed upon by the National Physical Laboratory and the Laboratoires Centrals d'Electricit^{e}, Paris, and constitute the first authoritative data on the resistance of aluminium to be published in this country. The British standards of resistance of aluminium for electrical conductors are being submitted to the International Electrotechnical Commission for adoption as international standards. Copies of this new publication—No. 215, 1925—may be obtained from the B.E.S.A. Publication Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

THE Department of Overseas Trade is informed that the thirteenth annual International Agricultural Exhibition will be held in the Palais du Cinquantenaire, Brussels, from February 20th to 28th, 1926. The Exhibition is being organised by the Société de Mécanique et d'Industries Agricoles, 20, Rue Neuve, Brussels, from which application forms and regulations may be obtained.

Characteristics and Uses of Ground Gears.*

By H. F. L. ORCUTT, of Birmingham, Member.

PART I.

Introduction.—There is at present a demand from engineers for high duty spur gearing. This demand will increase when there is a wider knowledge of the service that it is possible to secure from the straight spur gear made from hardened steel with the teeth accurately finished. The ground gear is practically a new mechanical product except in motor car practice, and even in the motor car gear-box it is adopted by only a portion of the automobile makers. Hence it may be said that its application or use is so limited that it may be almost regarded as unknown in general engineering, for its virtues, characteristics, and difficulties of production are understood by very few.

The object of this paper is to set forth the peculiar features of the ground gear and to make suggestions for its use in engineering work for which it may be specially adapted.

Characteristics of Ground Gears.—The two outstanding characteristics of ground gears are :—(1) Extreme accuracy and (2) the possibility of making a straight tooth spur gear of material with any desirable physical properties. Any alloy steels or heat treatments can be specified, and even with the hardest material an accuracy of tooth finish with limits of errors even smaller, with few exceptions, than are demanded in cylindrical grinding can be obtained. This combination of high grade material and accurate finish of the teeth would be impossible without the grinding wheel. The standard of accuracy which is required in ground gears to make them superior in endurance and noiselessness to cut gears is not generally understood, and it is desirable to say a few words on this subject.

The ordinary commercial gears with the teeth either hobbed, milled, or generated give satisfactory service when they are run at slow speed and when they are not too heavily loaded. The same gears when run at high speeds develop objectionable noises, and unless they are lightly loaded have a short life. Cut gears with straight teeth, as used in the motor car gear-box, begin to develop objectionable noise even when run at light loads and low speeds.

Experience in motor car work has demonstrated that to secure quiet running, errors in gear tooth shape, in placement of teeth and indexing, must not exceed 0.0003in. It is believed that the task of keeping the errors of 250 teeth—the average number in an ordinary gear-box—uniformly within this limit is, as a mechanical operation, without parallel in production. It certainly cannot be achieved with any cutting tool but the abrasive wheel, and it demands the employment of the most accurate and refined grinding machine. It calls for special experience, highly special measuring instruments and extraordinary inspection and supervision. In fact, the production of really quiet gears requires a special organisation and equipment, which the ordinary manufacturer can rarely, if ever, afford to operate. The reasons why this accuracy is essential must now be examined.

In straight spur gears all tooth action takes place by sliding and all tooth contact occurs on a line. There is, moreover, the additional complication that the load is constantly transferred from one tooth surface to another. This action takes place in an incredibly short time, in many cases 100,000 and even 200,000 times per minute. It is so often taught that, in properly designed gears, tooth action takes place by rolling that it seems desirable to examine the first of these two statements in a little detail.

The model exhibited, see Figs. 3 and 4, is designed to show the fundamentals of involute gear tooth action. It shows the base circle, the line of action and the pressure angle of two gears each with 15T. These gears are 3 diametral pitch, 18 deg. pressure angle. The model is eighteen times the natural size. The spaces between the numbers 1–2–3–4–5–6–7 are equal divisions on the line of action. The spaces between the numbers on the gear teeth are the adjacent sliding surfaces of the driver and the driven teeth, and are divided as to contact to correspond with the numbers on the line of action. The model is movable, to show what is so often not clearly understood, that is, the sliding action of gear teeth one on the other.

The statement that contact takes place on a line cannot, of course, be challenged. The line of contact should be straight and continuous. If it is not, noise is the result. The greater the departure from exact contact the greater the noise. If these conditions are kept in mind, it is not difficult to understand the importance of especially accurate indexing and of smooth tooth finish. The abrasive wheel gives the desirable qualities of finish and accuracy of form and it is practically impossible to secure them with any other cutting tool.

Hence there is in the gear grinding machine the only instrument which will produce straight teeth gears which will run quietly at high speeds. Moreover, gears with the teeth finished by grinding have special characteristics of great importance to the mechanical engineer. These characteristics are of such a nature that they make possible new developments in power transmission. They will be briefly noted.

The ground gear finished to a degree of accuracy necessary to quiet running possesses full theoretical efficiency in respect to load, life and stresses. Contact can be maintained along the full width of the teeth and with perfect regularity from top to bottom of the working surface. These qualities are not found in any cut gear, and in all gears which are hardened after cutting there is still greater departure from them. In ordinary cut gears the loads are constantly shifted from one part of the tooth to another, and, owing to irregularities of form, stresses are concentrated on high spots. The gear which is hardened or heat treated after cutting has much more strength than the soft steel or cast iron gear. It is, however, on account of excessive irregularities impracticable for high speeds. It must have very large dimensions, as load is constantly thrown on to short lines of contact.

Fig. 1 is well worth detailed study. The irregularities of tooth finish illustrate what is found to a greater or lesser degree in gears which are hardened after the teeth are cut. The measurements shown were made on a gear and pinion which are used in electric railway service. This gearing gives a much better service than soft gears, but it is noisy and of excessive dimensions and weight for the loads it carries. If run at a very fast speed it is quite evident that excessive hammering would occur. Irregularities increase as wear takes place. The back-lash variation in this pair of gears is over 0.040in. with a maximum of over 0.060in. A gear and pinion of these dimensions with ground teeth could have a back-lash variation of no more than 0.003in., and be finished to give any desired amount of back-lash. The teeth would be parallel with a maximum error of 0.001in. Excentricity on the pinion need not exceed 0.001in.

Another interesting record of errors is given in Fig. 2, which represents what is found in the ordinary tramway pinion. This pinion is steel, hardened after tooth cutting.

Gear makers and steel makers have given much attention to the quality and treatment of steel which would have a minimum distortion when heat treated. When the teeth of gears are to be ground, any reasonable distortion need not be feared. This is important, for it permits of the use of material which can be selected solely on account of its physical properties and which can therefore be made of minimum dimensions. In practice the best combination of these desirable qualities is found in a case-hardening steel.

Although the greatest distortion takes place in such steels, these give the longest life and bear the heaviest tooth loads. Hardening distortions vary with sizes and shapes of gears and must obviously be kept within certain limits. In small gears as used in the motor car box, a grinding allowance from 0.003in. to 0.005in. is necessary on each side of the teeth, of from 0.006in. to 0.010in. on the tooth thickness. On large diameters up to, say, 30in., 0.040in. on the tooth thickness is necessary or all teeth will not completely finish.

Advantages of Ground Gear Teeth.—With full theoretical efficiency and no limitations respecting choice of material, straight spur gears can be designed with minimum dimensions. This is valuable in many cases where restrictions

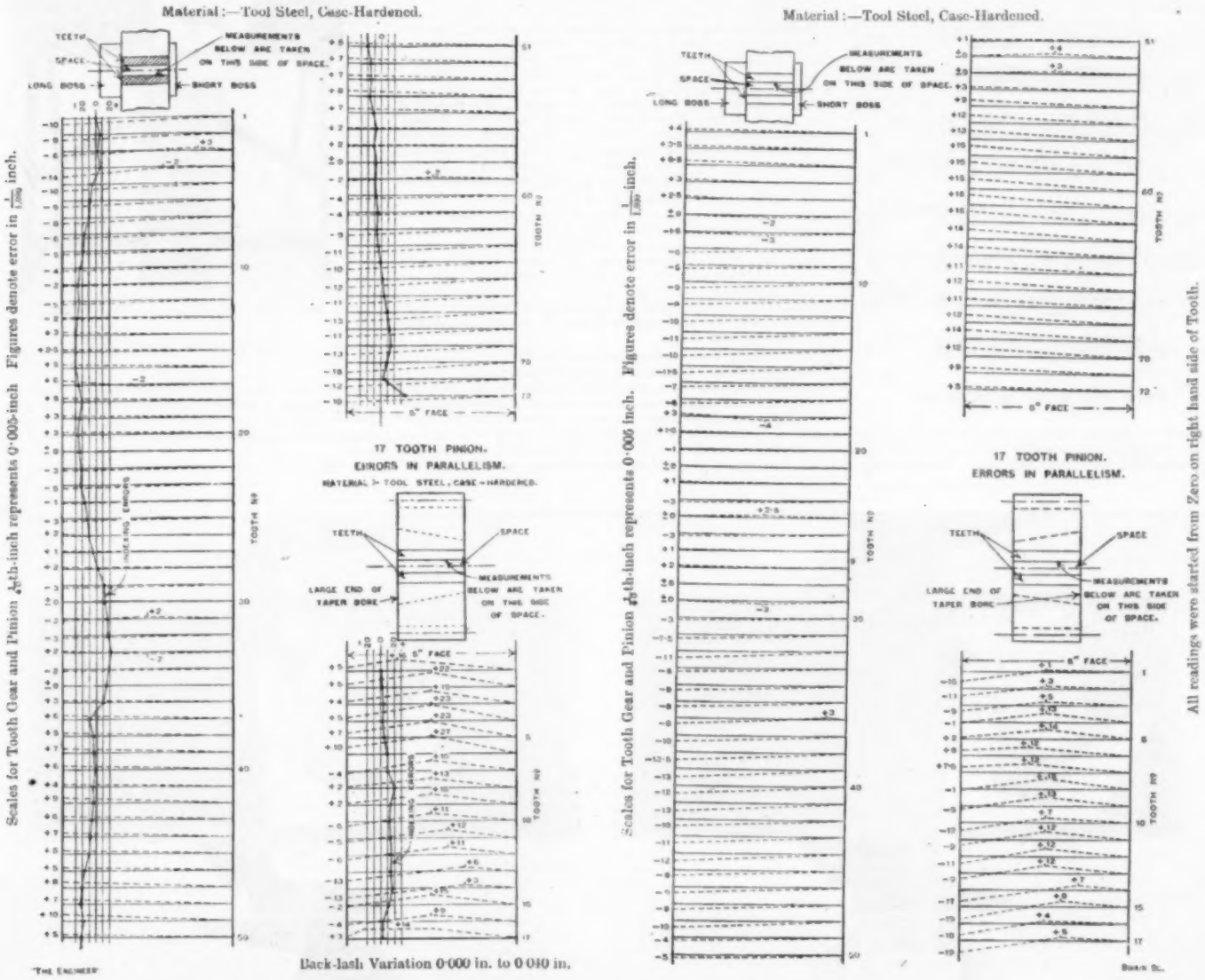

Material :—Tool Steel, Case-Hardened.
TEETH
SPACE
MEASUREMENTS BELOW ARC TAKEN ON THIS SIDE OF SPACE.
LONG BOSS
SHORT BOSS
Scales for Tooth Gear and Pinion 1/1000th-inch represents 0·005-inch
Figures denote error in 1/1000 inch.
TOOTH NO
8" FACE
17 TOOTH PINION.
ERRORS IN PARALLELISM.
MATERIAL :- TOOL STEEL, CASE-HARDENED.
LARGE END OF TAPER BORE
Back-lash Variation 0·000 in. to 0·040 in.
Material :—Tool Steel, Case-Hardened.
Scales for Tooth Gear and Pinion 1/1000th-inch represents 0·005 inch.
All readings were started from Zero on right hand side of Tooth.

FIG. 1—ERRORS IN PARALLELISM OF 72-TOOTH GEAR

* The Institution of Mechanical Engineers.

are imposed by weight and space. A good example is found in a pair of reduction gears, many of which are in service in a well-known maker's aeroplane engine, with the following dimensions :—

Gear, 12·48 P.D.	H.P. transmitted, 650.
Pinion, 5·34 P.D.	Load per inch of face, 3450 lb.
Teeth, 3·9326 pitch.	Peripheral speed of gear, 2650ft. per minute.
Width of gear, 2·6in.	

Any number of gears in motor car gear-boxes are in use carrying a load of over 3000 lb. per inch of face. As a contrast, many electric railway gears are in use carrying loads of only 1200 lb. per inch of face. Theoretically the latter might be reduced in width to one half the size commonly used, that is if properly selected material were employed and the teeth were accurately finished by grinding after hardening.

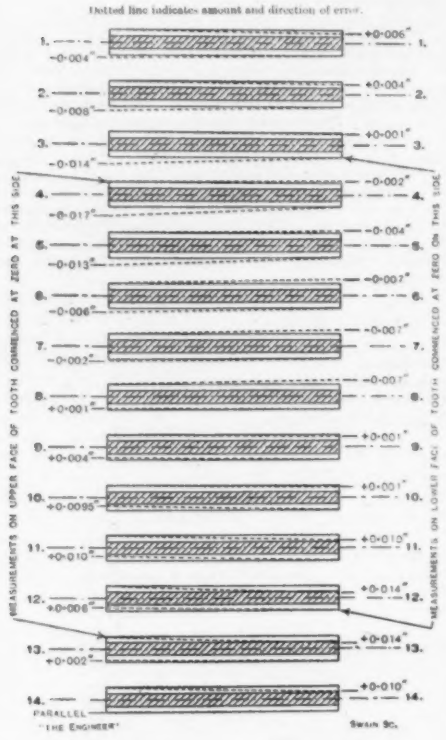

Dotted line indicates amount and direction of error.
MEASUREMENTS ON UPPER FACE OF TOOTH COMMENCED AT ZERO AT THIS SIDE
MEASUREMENTS ON LOWER FACE OF TOOTH COMMENCED AT ZERO ON THIS SIDE
PARALLEL
"THE ENGINEER"

FIG. 2—ERRORS OF PARALLELISM

For railway gears the factor of safety on the gears as now made is 16 on the elastic limit. The question is—could the factor of safety be reduced to five without danger of rupture from shock loads ? So far as is known no tests have been made covering this possibility. The gear in the motor car stands enormous shocks and great abuse, and rarely fails.

The demand for gears running at very high speeds is rapidly increasing. As a direct, simple, cheap and reliable means of transmitting power, the ordinary spur gear is unequalled for many purposes. When made with straight teeth, however, the ordinary cut gear will only permit of a comparatively slow speed. Not very much is known as to possible speeds attainable with ground gears. So far as tested, however, it seems that quiet running can be secured with high grade gearing with practically unlimited speeds if the teeth are accurately ground, are not overloaded, and the gears are correctly mounted. A peripheral speed of 3000ft. per minute is commonly in operation with quiet running, and it is reported that there are in use ground gears transmitting considerable power at a peripheral speed of no less than 10,000ft. and even 20,000ft. per minute.

Direct comparative tests have been made which demonstrate that gears accurately and smoothly finished have longer life than those which are inaccurately or roughly finished. It is suggested that many cases of so-called "pitting" are directly due to rough or inaccurate finish, the theory being that rough projections on the teeth are pushed by sliding action towards the pitch lines, and near the pitch lines particles of metal are pressed into the surfaces of the teeth, causing these well-known blemishes. Support is given to this theory as pitting action is always found close to the pitch lines of the teeth where sliding action is the least, and rolling action is more nearly approached and lubrication is less effective than on those parts of the teeth where sliding action is most pronounced. In theory it seems that the ground gear should have the longest life, as it is a fact that in nearly all mechanical action the maximum wearing qualities exist in those surfaces which most nearly approach mathematical perfection. Actual service tests have shown that railway transmission gears with ground teeth outlast all others.

It is quite possible that there will be distinct advances in gear tooth service when more gears are designed with a long line of action with as many teeth in contact as possible. Multiple tooth contact is, however, not of much practical value in gears when they are finished by ordinary cutters or are hardened after cutting. The slightest imperfections of indexing or of variation in form prevent division of the load, which should in theory be evenly distributed on two or more teeth.

Back-lash, under certain conditions, directly affects the life of gearing. It is much talked about and much misunderstood. To it are attributed erroneously many evils ; with its elimination are expected many improvements. It should be mentioned in passing that it does not affect noise, speed, nor to any great extent load capacity. A certain amount is just as necessary to good gear running as clearance is to good spindle running. But the amount of it must be strictly under control, and it has already been seen that variation can be limited to a fraction of a thousandth of an inch by grinding as compared with variations ten times as great in cut and hardened gears. Uniform teeth forms and uniform back-lash are, of course, natural accompaniments.

Recent tests have been made in America to obtain definite data as to effect of inaccuracy of spacing on the strength of gear teeth at high speeds ; it was found that, in a broad way, at pitch velocities of 1000ft. per minute and upward, gears whose inaccuracies of spacing do not exceed 0.001in. will carry twice the load that those having inaccuracies of spacing of 0.006in. will ; and the strength of gears having inaccuracies of spacing of 0.002in. is about halfway between the two. These tests were on cut gears, but they are significant and applicable, of course, to ground gears.

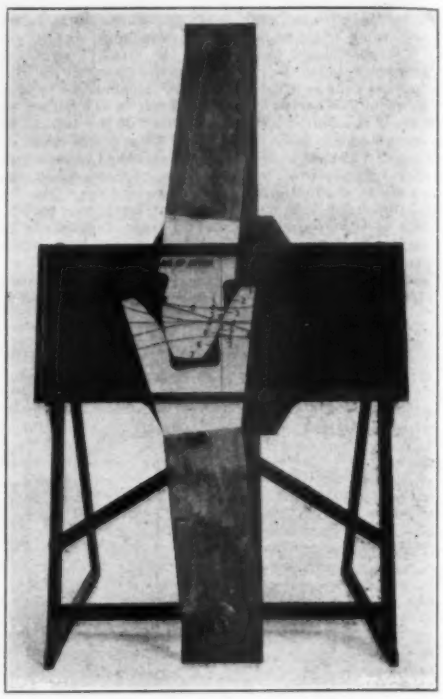


FIG. 3—GEAR TOOTH MODEL

Conditions which, as far as known, seem indispensable to the best running results for straight spur gears, may be briefly summarised :—

(1) Accurately formed teeth.
(2) Indexing as near perfect as possible.
(3) Teeth with sections and area well above those demanded by the load they must carry.

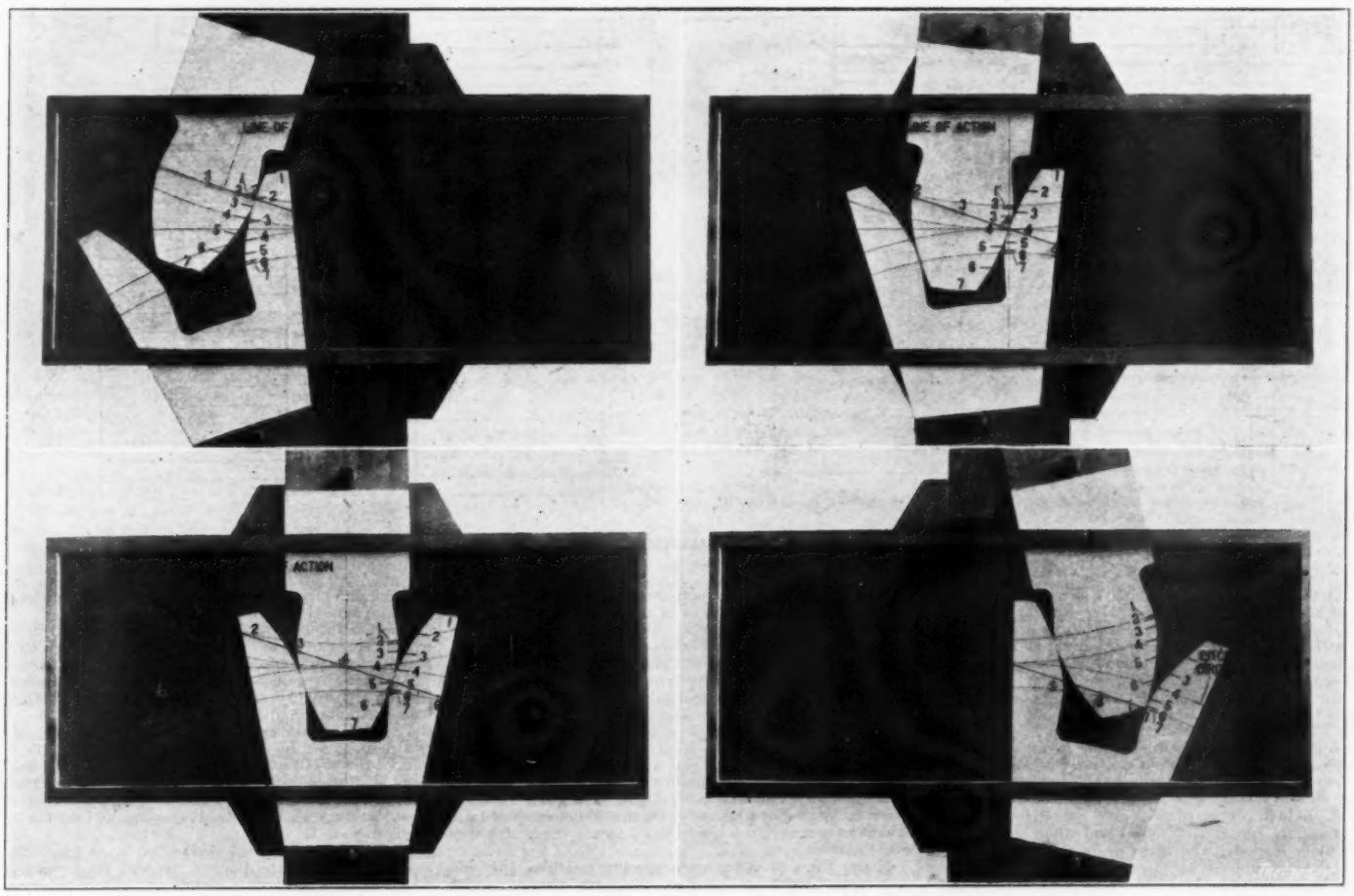


FIG. 4—INVOLUTE GEAR TOOTH MODEL IN CONSECUTIVE POSITIONS

(4) Gears mounted so that good tooth contact is maintained.

(5) Connecting drives and transmitting shafts, if possible, arranged so that oscillations and vibrations are not transferred to the gears.

In respect to (1) and (2) it may be predicted that the ground gear will more closely approach perfection than any other.

(To be continued).

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Position Unchanged.

Business in the iron and steel industries of the Midlands and Staffordshire shows no further improvement. Recent progress appears to be maintained, especially in the constructional steel, pig iron and galvanised sheets departments. The increase in demand, however, is not followed by higher prices. Indeed, in the steel section the struggle for turnover has resulted in a further fall in values of constructional materials. Competition is keen and continental firms have this week quoted new reduced prices for various classes of iron and steel for delivery into the Black Country. Midland iron and steel masters continue hopeful, though they do not anticipate any great revival in trade before the New Year.

Steel Values.

The general condition of the steel trade remains unsatisfactory. While in some departments the volume of business is improving, over-supplies prevent it from impressing itself on prices. Steel orders are nearly all for constructional purposes, demand for rails and shipbuilding material still being below the normal. The depression in the boiler trade has not been appreciably relieved. It is reported that plates have been offered this week at less than £11. Ship, bridge and tank plates, ¼in. and over, are quoted at £8, but business can be done at as low as £7 15s. The struggle for turnover has brought the price for angles and joists to £7 2s. 6d. minimum. Small bars are obtainable at £7 15s., if the specification is sufficiently attractive. Most mills are prepared to shade recognised quotations if a specification can be offered enabling an order to be proceeded with at once. One feature which assists business is the quick delivery secured from nearly all mills. Almost anything can be obtained within two or three days of the placing of the order. This is an important element in meeting foreign competition, slow delivery being an inevitable accompaniment to continental business. The Continent, however, is still keenly competing, and quoting very low prices. Several descriptions of Belgian steel are quoted 2s. to 2s. 6d. below even the quotations of a week ago. Ship plates at £6 7s. 6d. and steel sheets at £7 10s. f.o.b. Antwerp are both 2s. 6d. cheaper than last week. It has been found possible to quote untested joists which have a big sale in this country, at £4 17s. 6d. f.o.b. Antwerp, a further reduction of 1s. It is obvious that France and Belgium, both of which countries are unable to keep their mills fully employed, appear to be making a big fight to maintain their large deliveries to this country. The trade in billets shows little improvement. Native billets are quoted at £6 2s. 6d. to £6 5s. Belgian imports can be bought at £5 5s. in special cases—less has been quoted—but in those instances the business is speculative, and is not based on current market conditions. Steelmakers note with some pleasure that during October, though there was some recovery in the shipments of iron bars, rods, angles, shapes and sections, steel products in the same category likewise showed a well-marked advance, though the total was no more than 20,726 tons, as compared with 37,075 tons two years ago. Steel girders, beams, joists and pillars doubled the low tonnage of September. The volume of the trade in hoops and strips unfortunately continued to decline.

Galvanised Sheets.

The galvanised sheet trade is busy, easily maintaining its £16 12s. 6d. basis, with an additional 2s. 6d. for small tonnage or quick supply. Orders are practically world-wide, and are nearly all for next year's delivery. Buying is not quite so brisk as it was, but that is merely the usual reactionary lull, and the mills are in a strong position, being well furnished with orders until January or February next. This branch of the trade is retaining its overseas markets very successfully. It would be necessary to search a long way back to find a month in which the exports of galvanised sheets compared with last month's total of 66,572 tons. The nearest approach to it this year was in March, when 64,350 tons were shipped. Exports for the ten months aggregate 589,773 tons, against 544,528 tons last year and 489,974 tons in 1923. The recent improvement in the tin-plate trade is maintained, prices being somewhat more favourable to the manufacturer on the basis of £1 per box.

Steel Scrap.

Progress in steel scrap is maintained, consumers paying £3 7s. 6d. for delivery into South Wales. It is noticeable that scrap imports have fallen off to a remarkable degree lately, being only about one-fifth of what they were last year, and as British stocks of material are not large, better prices are looked for in the future.

Staffordshire Bar Iron.

The call for finished iron from the Staffordshire mills has again fallen off, and the industry is in a poor condition. Orders for best quality bars are rather small generally, though the aggregate has been such that isolated works have been able to keep in full employment. Fortunately, there is practically no competition from outside in this department, and the basis price of £14 10s. is maintained. There is only a narrow market for Crown and common bar iron. Prices are dictated largely by the Lancashire mills, whose quotations remain 10s. below those nominally ruling in Staffordshire. Many mills in this district, however, are prepared to do business below the £12 and £11 basis. It is little which comes their way, however. What Lancashire makers do not secure goes to the Continent. Were it not for the re-rolling of steel which many of the mills have taken up in the absence of iron orders, the position of the Black Country and South Staffordshire generally would be almost hopeless. The stoppage of the Patent Shaft and Axletree works at Wednesbury is an unpleasant reminder of the difficulties still confronting local industries. The tube trade continues active, and takes good quantities of welding tube at £7 10s. delivered and a small quantity of iron is called for for the same purpose, though this costs nearly £4 more.

Pig Iron.

The pig iron market has not lost the accession of strength it received last month, but the restricted basis on which bargaining proceeds does not make for confidence. Values are maintained, but as coke is dearer, and imported ore costs more through increased freights, smelters would be very glad to raise prices. The improved demand, especially in the direction of exports, has absorbed existing stocks, and the pig iron now made goes into consumption. In the Midlands buying has not been quite so keen lately, the forward contracts made a fortnight ago having covered requirements practically to the end of the year. Owing to some evidence of revival in foundry pig iron last week's quotations are strictly adhered to, and merchants report buying in a few instances up to 100-ton lots. Six weeks ago the same consumers restricted their business to about half that quantity. Stocks generally are nearing depletion, but beyond the restarting of a furnace in Northamptonshire, there does not appear to have been any further developments making for increased output. The flatness of business in forge pig is a gloomy commentary on the plight of the Staffordshire wrought iron trade. It is commented upon that our exports of pig iron in October were larger than any previous month of this year. In March, and again in August, we bought almost as much pig iron as we sold abroad. It is interesting to note that outgoing shipments for the past ten months aggregate 370,766 tons, whereas the imports amounted to 219,841 tons. Last month we exported more than thrice the tonnage received from abroad.

Encouraging Signs.

The exports of iron and steel during the month of October clearly demonstrate the improvement which has taken place in industrial conditions in these industries. The expansion in exports to which the October returns testify must be encouraging to producers. The course of business has been so erratic, however, that there will be hesitation about drawing too sanguine inferences from the experience of one month. Shipments comprised 368,823 tons, value £6,437,397, compared with 273,237 tons, value £5,065,214 in the previous month. This is a much bigger leap forward than October accomplished in either 1923 or 1924. The turnover was not so large as two years before, but it was substantially larger than in October of last year; in fact, we have to go back to May, 1924, to find a month in which our exports of iron and steel and manufactures thereof equalled those of the month just past. It is noted, however, that while our exports increased on the month by 95,586 tons, imports were up 19,204 tons.

Cast Iron Research.

At the annual meeting of the British Cast Iron Research Association it was mentioned that the Association had reached a critical period in its history, in that it had entered upon the fourth year of the term of five years which the Department of Scientific and Industrial Research had given it to become self-supporting. It will be remembered that in common with other technical institutions that came into being on the initiative of the Government after the war, this Association was promised that for each £1 raised annually in the form of regular subscriptions, an equivalent amount would be paid to its credit out of the million fund set apart for the encouragement of industrial research. On behalf of the Association, an undertaking was given that an income of £12,500 would be raised for the full five years. Last year there was a considerable quickening in the movement. The membership and income were materially strengthened, and there is good assurance that the obligations accepted by those who are interested in the enterprise from the technical and trade side will be fulfilled. Moreover, it is an open secret that the Association proposes at the expiration of the period for which the Government undertook to assist the organisation, to apply to the Department of Scientific and Industrial Research for further financial support for another term of five years. The value of research is still very insufficiently understood, but the work which is being done by this and kindred associations commands increasing appreciation. Future opportunities of service must depend very much upon those whose material interests are bound up in the success of the movement. The Council considers that the work is now well established, but it will only fulfil its purpose completely when all the British-controlled grey iron foundries, engineering works, malleable plants and blast-furnaces are represented in the membership. Research and experimental work prosecuted during the last year extended to sixteen different problems. Specifications for white heart and black heart malleable iron have been virtually completed by a sub-committee, and it is hoped they will be issued shortly by the British Engineering Standards Association. A specification for grey iron is also in active preparation. It is greatly to be hoped that when the time comes the Government will see the wisdom of continuing financial aid to this important branch of industry.

Chain and Anchor Trade.

It is to be regretted that October did not maintain the improvement reported in September in the external sales of anchors, chains and cables. It may be noted that out of the total shipments of 1184 tons, Germany took 116 tons. This old Black Country industry is so badly hit by the inactivity in the shipyards at home that the assurance recently given out that South Staffordshire will not be forgotten when the contracts for new Admiralty construction are distributed is welcomed.

Birmingham Brass Trade.

That the Birmingham brass trade is emerging from the slump of very bad trade which has clouded it for a considerable time is the impression of many of the manufacturers associated with the industry in this area. Mr. B. B. Blackburn, who presided at the annual dinner of the Birmingham Brassfounders' Employers' Association, shares this view, and reminded them that they had now to face the music of setting their house in order and re-establishing their trade upon a remunerative basis as before the war. The brass trade had a long way to go before it assumed the position it held before the war. They had to conquer their dislike of scientific thought and method. They must educate themselves in trade economics, develop foreign markets, encourage research and get down the cost of production. In respect of cost of production, they had to seek the co-operation and help of the men employed in the industry.

Unemployment.

On November 9th it was reported there were 125,827 persons unemployed in the Midlands. The latest return, compiled for the week ended November 16th, shows there has been an increase to 126,453, and that increase is accounted for by the greater unemployment at Derby, where the figures have advanced from 1561 to 2388. In the Birmingham, Coventry and Black Country areas the improvement in the position is maintained, though in Wolverhampton the figures are up on the week by 62. The present total is made up as follows:—95,283 men, 1963 boys, 26,715 women, 2492 girls. There are now unemployed in the Birmingham area, 21,627; Bilston, 2317; Coventry, 1783; Cradley Heath, 3857; Derby, 2388; Dudley, 3165; Leamington and Warwick, 389; Leicester, 4010; Northampton, 1818; Nottingham, 7992; Oldbury, 1187; Peterborough, 350; Redditch, 1074; Smethwick, 2830; Stoke-on-Trent area, 13,220; Stourbridge and Brierley Hill, 3259; Tipton, 1727; Walsall, 4008; Wednesbury, 2766; West Bromwich, 2342; Wolverhampton, 4140; Worcester, 1644.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

The markets here for iron and metals are fairly steady, but quieter than they have been. Consumers seem inclined to hold back after the recent buying, and there is scarcely so much confidence in the future as there was at the beginning of the month. Nevertheless, it is difficult to believe that prices can be very much lower than they are at present, and public utterances just now seem all to be on the optimistic side. Of course, these must be taken with reserve, for optimistic speeches on industrial and commercial themes have been a feature of the last three years of persistent depression. The rumours of a coming trade boom in America continue; and if any "boom" is to come it would naturally start in the United States, but one doubts whether Europe is yet ready for anything of the kind, and in Great Britain we have serious labour difficulties to get through.

Metals.

The market for the non-ferrous metals seems to be in rather an uncertain condition. The views of the future usually expressed here do not seem so favourable as they were, although, of course, it is generally admitted that copper cannot fall very far in any case. The history of the movements in the copper market for the last three years supports the belief that when standard copper touches £60 per ton it is as cheap as can be reasonably expected. There have been one or two occasions when £60 has been broken, the last occuring in June this year and another in April, but these prices below £60 did not last for more than a day or two; and the inference is that when standard copper is near £60 per ton, those who will need copper during the next two or three months will do well to secure their supplies. At any rate, such a policy must have paid the consumer any time during the last three or four years. There has been a bigger American consumptive demand for copper, but the consumption on this side seems to be adversely affected by the weak financial position in Germany. The prices for manufactured copper and brass in this country remain comparatively high, and when one compares the apparent costs of manufacturing copper and brass with those charged for manufacturing spelter and aluminium, some curious anomalies are seen. The position in regard to scrap copper and brass does not show much change. Dealers here give very much the same prices as they have been paying for the last six months. Ordinary mixed scrap gun-metal is comparatively cheap and plentiful, and good heavy scrap yellow brass is also to be had at a very much lower price than the cost of mixing the metal from copper and spelter. In the market for tin there seems to be some uncertainty, but on the whole the balance of opinion is in favour of higher prices. There are experts—or professing experts—in the market who prophesy that during next year tin will again reach £400 per ton; but this seems a very extravagant view to take. More modest people content themselves with expecting £300 by the end of the year. No doubt the statistical position is favourable, and it is quite impossible to say what might happen. The outlook for lead is not quite so favourable as it was. There is always the prospect of large arrivals of Australian lead, which might easily depress the market in January and February. Spelter is a fairly steady market, and does not seem to be in any danger.

Pig Iron.

The markets in Lancashire for foundry iron are steady and quiet. It is generally admitted that the iron-founders have obtained more business lately, and more iron is being melted, but the purchases of the last three or four weeks are probably ample for all the new needs of the foundry trade, and only a small amount of buying is going on at the moment. On the other hand, there is no pressure to sell on behalf of the furnaces. There are orders in hand which will keep makers employed up to the end of the year, and by that time, or at least early in January, it is expected that another wave of buying may set in. At any rate, there is no weakness in foundry iron prices here, whatever may be the case with the steel-making irons, or with forge pig iron. For the latter there is not much inquiry, although it is no worse because the strike in Belgium gives a better opportunity to the Lancashire bar iron manufacturers. Sellers of Derbyshire No. 3 foundry iron still quote 73s. 6d. per ton for delivery in Manchester and the neighbourhood. Staffordshire pig iron is a little dearer than this, and Lincolnshire about 1s. cheaper; but the main business now is confined to Derbyshire iron, and this no doubt enables makers to feel fairly secure as to the price. Fortunately for the stability of the market, the recent advance has not been nearly enough to induce owners of idle furnaces to put them into operation; and if it be true that furnace coke is to be dearer next year, a very considerable further rise in selling prices would be necessary to bring pig iron making into the list of profitable occupations. The demand here for Scotch iron is said to be a little better, and of course this would be the natural result of any improvement in the demand for textile machinery; but Scotch iron cannot regain its old position in the foundry trade here until it can be brought to Lancashire at much less expense. East Coast hematite has been a little firmer, but is still very much cheaper than Scotch iron. On trucks at the furnaces it stands at much the same price, but the difference in the carriage tells in its favour.

Steel.

The market for finished steel is rather better so far as inquiry is concerned, and there is probably rather more actual business passing; but the prices are utterly disorganised, and one does not know at what lowest price business in plates or sections could be done. Nominally, £8 2s. 6d. is the ostensible price for steel plates in Manchester, but there have been reports of business at as low as £7 10s. The price seems incredible, but evidently merchants believe that something of the kind has been done. Boiler plates are steadily held, and these, with thin sheet steel, are now the only profitable portion in the steel business. There has been a little more business in Lancashire iron, probably to supply the place of foreign iron, the delivery of which has been delayed.

Scrap.

Some little improvement may be noticed now in the market for scrap materials. An inquiry for heavy wrought scrap is natural as a result of a better demand for local bar iron, and dealers quote 67s. 6d. per ton and are trying to get the price up to 70s. Some inquiry for steel scrap has also come from Sheffield, and dealers here have been paying up to 52s. 6d. on trucks for melting quality. There is plenty of cast scrap about, and although the foundries have been open for a little more, the prices have not yet been advanced beyond 72s. 6d. for good broken machinery metal and 75s. for best textile scrap.

BARROW-IN-FURNESS.

Hematite.

The West Coast hematite pig iron trade is still improving slowly but surely. The demand is becoming greater and the stocks which have been standing at some of the works are being reduced. This fact is noticeable at Ulverston, for instance, where stocks had accumulated considerably. The furnaces were damped down, but now they are being got ready again, and in a few weeks they will be working. This is good news, and points to a better state of trade generally. It would seem that users of West Coast pig iron are experiencing better business, and are consequently taking more iron and are likely to do so. The Midlands are taking a fair tonnage, but there is still a tendency to place orders for immediate requirements and to postpone contracts for forward deliveries. Confidence is not quite restored. The steel departments at Workington and Barrow are taking a considerable portion of the output. The business in special qualities is growing, and may in time result in another furnace going into work in Cumberland on ferro-manganese.

Iron Ore.

There is a better outlook for the iron ore trade now that there are more furnaces in blast, and a prospect of two more being restarted. The local mines are not sending much out of the district as yet, but this side of the trade may improve as Scotland gets busier. The Cumberland mines are doing most business, but more activity is likely in the Furness district. As regards foreign ore the demand is increasing, and there will be heavier shipments of Spanish and Norwegian ores in due course.

Steel.

The position in the steel trade is slightly better, but there is not a sufficient bulk of orders to guarantee regular running for a long period. Fresh orders have been secured, but they are not heavy enough to keep the rail mills fully employed for months to come. The market has slightly improved, but competition is keen and the prices which rule allow of little or no profit.

Shipbuilding.

The Orient Liner Otranto is nearing completion, and is already scheduled for sailing to Australia. No fresh orders for ships have been reported as yet, but there is a prospect of some more work in the near future if rumour is right. The Isle of Man Steam Packet Company's steamers are laid up for the winter at Barrow, and the principal boat, the Viking, is undergoing repairs and overhaul at Vickers'. This vessel met with a mishap when on her station, and the repairs required are considerable.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

CONFIDENCE in the future of the steel trade is maintained in full strength, and, although there is not much actual gain of ground to warrant the feeling, some improvement is to be noticed in the lighter branches. The heavy side is not doing well. In crude iron and steel, conditions are actually quieter than they were at the beginning of this month, and there is not much likelihood of an early expansion, as the stocktaking period is at hand, during which consumers will no doubt keep deliveries to their works at as low a point as possible. At Templeborough, the United Steel Companies are operating eight of their fourteen large furnaces, but the same firm's melting plant at the Ickles is running at low capacity. One of the factors contributing to the present unsatisfactory situation is the depressed state of the shipbuilding industry. This important section is making very small demands on Sheffield, and it shows no sign of that recovery which proprietors of heavy forges are anxious to see. The railway steel departments are only fairly well employed. Rather more work has recently come through from overseas, but, on the other hand, the home companies are keeping their specifications down. Hopes of improvement are, however, based on the large programmes which have been announced for next year. The wagon building trade is very quiet.

The Lighter Side.

One of the brightest features of Sheffield trade at present is the state of those branches which supply material to the automobile trade. A very good demand is being experienced, both for drop stampings of motor car parts, and for steel used in the construction of the engines and gears. The majority of the steel and tool firms, both large and small, are getting a share of the business coming from this source. Just as stainless steel came to the rescue of the cutlery trade a few years ago, so it may be said that the demand for motor car parts is now saving the steel trade from very severe depression. There is a somewhat better state of things to report with regard to tool steel, which appears to be just beginning to recover after a long period of great slackness. It is believed that the enormous accumulations of surplus war stores are at last exhausted, and that the requirements of new material will grow. Some trade is still being done with Russia, as, although access to the ports is interfered with by ice, there are some routes which will remain open throughout the winter. The outlook for trade with that country when transit conditions are again normal is considered good, as there are large inquiries on hand for files, saws, edge tools, mechanics' tools and agricultural knives.

Fuel Research.

An important conference on solid smokeless fuel was held in Sheffield last week, under the joint auspices of the Society of Chemical Industry and other technical societies. Sir Arthur Balfour, chairman of the Committee on Industry and Trade, who welcomed the conference to Sheffield, remarked that there was an improvement in trade, and that it was gradually spreading, but nothing would spread it more quickly than some new method of using fuel more economically, or applying a new type of fuel to locomotives or something of that description. What they needed, to put into use the immense amount of plant which had been left over by the war, not only in this but in other countries, was some great invention, such as electricity or steam. Some fine morning they would wake up to hear that some great invention of that kind had taken place. Only incessant research and effort such as that conference was putting forward could accomplish this, and for that reason the industry and trade of Sheffield gave the delegates a hearty welcome.

Rustless Steel Progress.

Some months ago Thos. Firth and Sons, Ltd., in whose laboratories stainless steel was discovered, put on the market a new variety of rustless steel named Staybrite, the distinctive quality of which is that, if heated to a high temperature and quenched, it is rendered extremely soft and ductile. Whereas the original chromium stainless steels contain 12 to 15 per cent. of chromium, the proportion of that element has been increased to about 18 per cent., and nickel has also been added to the substantial extent of about 8 per cent. A lecture on the progress of this new steel was delivered last week before the Sheffield Trades Technical Society by Dr. W. H. Hatfield, the present head of the Brown-Firth research laboratories. He said that it was found that the composition just referred to produced a steel which was readily worked either hot or cold, and which was free from the hardening and even air-hardening characteristics of the earlier steels. This chromium-nickel steel, he added, had now been thoroughly developed as regards production, and was available in the form of sheet, strip, bar, section, wire and tube. It was also obtainable in the form of castings. The increase in the chromium content, together with the addition of nickel, had resulted in a marked increase in the resistance of the new steel to corroding media. It even completely and satisfactorily resisted marine conditions—that was, the action of sea water and spray—under the searching circumstances of being alternately wet and dry. It would resist nitric acid of all strengths, and at all temperatures up to and including the boiling point; as well as citric acid, acetic acid and lactic acid. Dr. Hatfield described the suitability of the new material for the production of spoons and forks and a variety of other articles, and showed samples of a number of deep and shallow dishes and pans which had been pressed and stamped from Staybrite. He expressed the hope that the lighter trades of Sheffield would thoroughly investigate the claims of this new metal with a view to extending their field of operations to include many articles which were not now manufactured in the city.

The Christmas Cutlery Trade.

The hopes that were entertained of a busy Christmas season trade in cutlery and plate have been disappointed. For some weeks during October the works were for the most part quite well employed, but at the end of that month there was a falling off in the demand, which has not recovered, and it is now becoming clear that the season has ended earlier than usual. A large proportion of the demand has been for small quantities, and it is probable that the special trade has been well below that of last year, not only in bulk but also in value. Very few substantial orders are now being received, and it is feared that serious buying has ceased for the year. Only a minority of firms are able to report a satisfactory year's operation, and there is reason to believe that a good deal of money has been and is being lost in both the cutlery and plate sections. The latter is the more seriously affected of the two. For high-class silver and plated hollow-ware the year has been a bad one.

The Storage of Celluloid.

Sheffield was last week the scene of a fire at a cutlery works which has called attention to the dangers of celluloid and the regulations concerning the storage of that material. The fire was in the celluloid store of the works, and was followed by an explosion, in which three firemen were injured. In accordance with the Home Office regulations, the store was constructed of fire-resisting material, but it appears that the danger, in the case of an outbreak, is not confined to the fire itself, but to the possibility of explosion, which is caused by the celluloid fumes after they reach a certain temperature. This double danger has received the attention of Messrs. Atkinson Brothers, cutlery manufacturers, Milton-street, who have a celluloid store constructed on lines which are claimed to be the safest known. The chamber, which has a capacity for storing 6 tons of the material, is made of cast iron plates, and measures 23ft. by 13ft. 6in. by 9ft. high. Its novel feature is the roof, which consists of slabs of oolite stone, 1½in. thick, and is not fastened down in any way. It is laid flat over wire netting gauze on the four walls, and provision is made for the passage of a current of air underneath it at all times. It is claimed that the fact that the roof is not fastened down reduces the risk of an explosion to a minimum. The whole structure is so built that no sparks can get in from outside. The chamber has been installed at the factory for five months, and its behaviour is being carefully watched by officials of the Home Office.

Notts. Colliery Railway.

The construction of a new joint line by the L.M.S. and L.N.E.R. railway companies, to meet the needs of coalfield development in North Nottinghamshire, is to be the subject of a Bill in the ensuing session of Parliament. It will be remembered that the original proposals of the L.M.S. Company, for a railway from Ollerton to the new pit at Edwinstowe, were dropped, as they would have meant interference with the natural beauties of Sherwood Forest. The two companies have now come to an agreement. It is proposed that the new line shall connect with their present systems at Hucknall and Papplewick, and should pass through portions of the parishes of Linby, Bestwood Park, Calverton, Oxton, Farnsfield, Bilsthorpe, Eakring, Rufford, Liberty, Ollerton, Wellow, Boughton, Walesby, Haughton, Bothamsall, Elkesley, and Babworth. The *Nottingham Guardian* reports that at Babworth a junction will be formed with the Sheffield and Grimsby Railway, while at Boughton there will be a junction with the Chesterfield and Lincoln Railway.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THE gradual movement in the direction of the re-establishment of normal conditions continues. The total volume of business passing in the iron and steel trades still leaves something to be desired, but the prospects are certainly brighter, and more and more plant is gradually being put into operation. The steel mills at the Acklam Works of Dorman, Long and Co., Ltd., Middlesbrough, which have been idle for twelve months, restarted this week. The steel furnaces were put into operation a fortnight ago, and as a result of the complete resumption of work, employment has been found for nearly a thousand men. The position in the pig iron trade has so far improved that further furnaces may shortly be started.

Cleveland Iron Trade.

The improvement in the Cleveland pig iron trade has been well maintained. The increased demand is proving to be no mere flash in the pan. On the contrary, buyers are displaying a readiness to negotiate business for months ahead, and in many cases a small premium is being asked for forward deliveries. It is especially gratifying that the broadening out of the home demand has been accompanied by improved export sales. Quite a lot of iron has been sold for shipment lately, and it would appear that continental consumers are becoming more willing to pay the extra price for Cleveland iron owing to the uncertainty in regard to deliveries from French producers. The statistical position is very strong, makers having small stocks. At the beginning of next week the Linthorpe Ironworks and an additional furnace at the Ayresome Ironworks will probably restart, and the increased output should tend to ease the pressure for deliveries, which at the moment are somewhat in arrears. Prices are steady, No. 1 foundry iron being 68s., No. 3 Cleveland pig iron 66s., No. 4 foundry 65s., and No. 4 forge 64s. 6d.

Hematite Pig Iron.

There have been a few more small sales of hematite pig iron to America, but the big business which was hoped for has not yet materialised. The demand on home account, however, continues very heavy, and the price of mixed numbers has advanced to 75s. per ton, with No. 1 quality at 75s. 6d. per ton.

Ironmaking Materials.

Extreme quietness still prevails in the foreign ore trade, but 20s. 6d. per ton c.i.f. Tees is now the ruling figure for best Rubio ore. Ironmasters are perturbed about the rise in coke prices. Up to 20s. 6d. per ton has been paid for good medium furnace coke delivered at the works, and the market rate is fully 20s. 6d. to 21s. 6d. per ton.

Manufactured Iron and Steel.

The manufactured iron and steel trade presents no new feature. There is a better flow of orders, particularly for rails and constructional materials, but for any small orders from shipbuilders competition is so keen that even current quotations, depressed as they are, might be shaded.

The Coal Trade.

The general position in the Northern coal trade is not so strong this week owing to a falling off in the inquiry. Prompt parcels of fuel are being offered at discount rates. Producers attribute the easier tendency to the shortage of tonnage, due to delays in arrivals through unfavourable weather, while merchants say that, though inquiries are numerous, orders are not coming forward as briskly as could be desired. Thus there are divergent points of view to account for the less active coal buying. Though the market is quiet at the moment, the collieries assert that they are comfortably situated to the end of the year, and that a passing difficulty with them is irregularity of loading turns through fog and other unfavourable sea conditions. Business maturing in Northumberland steam coals is of a rather small order, the general inquiry having eased to some extent. Values, apart from prompt, however, are being steadily quoted at late figures, and few sellers will consider reductions. Best steams range from 15s. 3d. to 15s. 6d. per ton. Steam smalls are quiet at late prices. Bests are well taken up at 9s. 6d., and seconds keep to 8s. 6d., with special kinds at 9s. 9d. to 10s. per ton. Although not so active as recently, there continues to be a fair demand for Durham gas coals, and prices generally are maintained. Gas coals are ranging from 16s. to 16s. 6d. per ton for bests, according to quality. The position in the coke trade is exceptionally strong. Gas coke makers are practically sold out to the end of the year, and new business is very limited, but the demand remains heavy. Other qualities are also in good request, and prices are firmly maintained.

SCOTLAND.

(From our own Correspondent.)

New Petroleum Works.

Plans have been passed by the Ardrossan Dean of Guild Court for the installation of extensive plant for the importing, blending and distribution of petrol by Shell-Mex, Ltd., whose Scottish divisional office is in Glasgow. On the ground acquired, which covers about 7 acres, eight tanks will be erected, with an aggregate capacity of about 5,000,000 gallons of petrol. The buildings include offices, filling shed, store, railway wagon workshop, and weighing house. A railway siding is provided for and a pump house will be built at Eglinton Dock and the petrol imported in steamers will be pumped through a pipe line from there to the tanks.

The Shale Oil Dispute.

In reply to proposals forwarded by the National Union of Shale Miners and Oil Workers, Scottish Oils, Ltd. states its willingness to refer the dispute to a committee of inquiry, but that it cannot agree to resume work on the old rate of wages pending the findings of the proposed committee. It is now reported that the safety men have been withdrawn from most of the works in the shale area. Consequently, unless the owners can maintain power to light the works, pump off accumulating water, and keep the air courses clear, considerable damage is likely to be caused while the mines are unoccupied. Further, the men employed at the Grangemouth refinery, where only imported crude oil is treated, have given notice to stop work in sympathy with their fellow-members. As work has already been stopped at the Uphall refinery, this will mean that the refining of imported crude oil will come to a standstill.

Steel and Iron.

There is a little more optimism with regard to the outlook in the steel and iron trades. While the present state of business does not appear to uphold such optimism, the impression is general, nevertheless, that steadier trade is within sight. At the moment, steel makers are disappointed at the turnover in sections, but plates are busier in comparison. Prices of both are weak. Sheets continue to prove the busy section of this industry. Thin gauges are particularly well booked. Galvanised sheets are especially busy. Reports from the ironworks are still unsatisfactory. Steel bars and small sections are in quiet demand, but the request for iron bars and sections is meagre, consumers in many instances preferring steel, owing to its cheaper price. Scottish pig iron is dull. Demands for all description are most irregular. Quotations for the different brands vary considerably, and there is no apparent firmness in prices generally.

Coal.

Weather conditions have interfered with business in the coal trade during the past week, and prompt orders have been scarce. Boats have been delayed by stormy weather, while the railway transit of minerals has been disorganised by dense fog. Lanarkshire splints have improved in tone, and the collieries are disposed to quote enhanced prices. Ells are steadier, owing to better home demands, but steams are barely firm. The Fifeshire and Lothian collieries have good orders for steam coals for shipment. Washed single nuts and pearls in all districts have stiffened, owing to increased home requirements. Washed double nuts in the Lothians are suffering as a result of the strike at the shale mines, where considerable quantities were consumed in normal times. Aggregate shipments amounted to 205,649 tons, against 255,141 tons in the preceding week and 246,872 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

The position in the steam coal trade this week is rather better, for the reason that the collieries have a more adequate supply of tonnage at their disposal. For once in a way, taking the whole of the ports in this district, there were more steamers waiting for berths than vacancies on Monday, owing to the number of vessels which had arrived over the week-end. The result was that collieries were able to find a ready outlet for their standing coals, and the general tone is steadier than it has been recently. It may be that the conditions will prove fairly favourable from now to the end of the year, but it is not so very certain that they will, for the reason that while a substantial amount of coals has to be lifted during the next few weeks, the fresh demand coming along is not quite so active. For one thing business, so far as France is concerned, is handicapped on account of the acute depression in the value of the franc. Buyers are consequently holding off and new inquiries from other continental sources cannot be described as brisk. Nevertheless a good deal of tonnage has recently been taken up, and undoubtedly the bulk of collieries should be able to work more regularly than they have done during the past few months. Apart from the usual British Admiralty requirements over next year, for which tenders have been sent in, the same authorities have asked for prices for about 50,000 tons of engine-burning coals for the depôts. So far as can be ascertained, no fresh business for delivery over next year has yet been done by foreign consumers or middlemen, and inquiries for America are not so numerous, notwithstanding that the strike of the American anthracite miners still remains unsettled.

Traffic Returns.

Statistics supplied by the Great Western Railway Company respecting the ports under its control in this district show that there was an improvement in trade during the four weeks ended November 1st, as compared with the preceding month, though for the ten months ended November 1st last the aggregate trade amounted to 28,995,733 tons, as against 34,015,543 tons for the corresponding period of last year, the decrease therefore being 5,019,810. All the ports shared this falling off, though, of course, the principal reduction was to be found in exports, which amounted to 24,547,267 tons, as against 28,886,077 tons, a decline of 4,338,810 tons. Coal and coke shipments came to 21,757,206 tons, which was less by 4,436,006 tons than the figure for the corresponding period of 1924.

Ship Repairers and Boilermakers.

The boilermakers, who had suspended work at the ship-repairing yards in this district on the question of the introduction of a rota system of employment, have resumed work, and a committee, consisting of three representatives of the employers and the workmen, is meeting to discuss the question of the more equitable distribution of work. The employers have made it clear that they will not, however, forego their right of selecting the men they desire to work for them. They intend to keep the management of their yards in their own hands.

Tin-plate Trade.

An important decision was come to at the end of last week by the South Wales tin-plate manufacturers. As the result of a conference it was decided that as from January 4th next the pooling of orders scheme is to take effect under the authority of a body to be known as the Tin-plate Conference. Sir J. C. Davies, who is the chairman of the committee of management, states that it is hoped that the new departure will have a very far-reaching effect upon the future of the industry in meeting foreign competition. After pointing out that the tin-plate trade employs 30,000 people in this district, that over £4,000,000 is paid annually in wages, and that about 1,250,000 tons of steel and 1,000,000 tons of coal are consumed, thus having marked effect upon other industries, Sir John Davies says that the object of the new scheme is not so much to keep up prices and profits as to provide for the better distribution of all the business and the labour that is available. The trade is a very scattered one, and under the old system, when one firm had plenty of orders and needed labour, others might have a superabundance of labour and few orders. The new scheme obviates this trouble. His view is that, provided there is co-operation between all the employers and the workmen, there is a splendid prospect for the trade. It is of interest to note that the Soviet Government of Russia has recently placed an order with Swansea and Llanelly firms for nearly 30,000 boxes of tin-plates. It is understood that an application on behalf of the tinmen for an increase of 15 per cent. is to be submitted to a meeting of the Joint Standing Committee of the Joint Industrial Council of the tin-plate industry at a meeting this week.

Current Business.

The inquiry for steam coals is on a fair scale, though scarcely as active as last week. Best Admiralty large are steadier, but second qualities are not relatively so good. Monmouthshire descriptions are comparatively quiet, but small coals are firmer. This is particularly the case with superior qualities, which are now quoted up to 12s., as against 10s. 6d. a week or so ago. Some of the patent fuel works are now better off for orders, but coke is without change. Anthracite coals are in fair demand, but the tone is a shade easier except for some of the sized qualities, which are well inquired for and are rather scarce. It is interesting to note that the inland demand for coals shows improvement.

The Institution of Civil Engineers.

OCTOBER EXAMINATIONS, 1925.

PASS LIST (*INTERIM*).

Preliminary (44).—W. J. Andrews, W. G. Beeson, J. E. Bentley, A. T. Black, G. C. A. Bryan, H. A. F. Canfield, G. H. Clegg, H. C. Davey, H. H. Evans, J. D. Fidler, H. J. V. Glenday, R. M. Hayes, C. T. Henfrey, F. Hewson, H. J. Hill, G. Hodge, J. D. How, A. H. F. Jiggens, W. F. Longfield, S. M. Outan, H. V. Phillips, R. S. Rendle, J. R. S. Rhodes, J. P. Richards, R. A. Russell, F. C. Sage, J. A. T. Shannon, F. A. Shorter, E. L. Simpson, J. M. Simpson, G. Slater, E. F. Smith, F. A. Smith, L. J. G. Smith, P. M. Spencer, J. F. G. Spring, G. T. Starling, E. E. Sweeting, E. J. Tonelli, N. Whear, C. I. Wilks, R. J. Willy, F. T. Wood, F. R. Wright.

Associate Membership (154).—*Whole Examination* (*Sections A, B and C*) (6).—H. Cliffe, W. Dixon, J. Dove, K. B. Robinson, H. V. Smith, L. Tulley.

Sections A and B only (14).—J. A. D. Anderson, E. H. Bacchus, R. C. Bond, W. E. Bulman, R. E. Downes Shaw, J. G. Gardiner, J. E. Gregory, J. F. Hand, W. M. Laird, G. J. Mair, J. D. Midforth, J. W. Pallister, J. A. Welch, A. G. Wheeler.

Sections A and C only (2).—J. F. Darnbrough, G. Perry.

Sections B and C only (10).—R. M. Drynan, H. Eaves, W. A. Knighton, A. L. Linford, P. V. Marchant, J. Penman, A. M. Rosie, Junr., N. L. Samson, W. S. Visick, D. R. Williamson.

Section A only (37).—A. Adlington, R. A. T. Anderson, D. B. Bald, L. Bendelow, H. W. Cameron, G. H. H. Collins, C. C. Cunnold, E. J. Davies, J. N. Deason, T. S. B. Dick, A. R. Dippie, H. D. Drummond, A. H. Eaton, C. B. Eck, G. H. Frotwell, R. W. Hall, D. Harry, H. Haughton, The Hon. G. A. R. Hay, H. S. Heath, G. Howell, N. H. Hunt, E. Hutton, W. B. Instone, N. Jervis, H. V. Langley, G. S. Lindsay, S. E. Lineham, D. Melville, L. F. Nicholson, M. W. G. Overton, A. L. Owen, P. H. Selbie, G. W. Warr, J. S. Whyte, T. Willey, H. Wolf.

Section B only (21).—R. L. Clack, R. S. E. B. Hart-Davies, J. Y. Hughes, A. C. M. Jansen, J. McAdam, G. W. Nash, H. Neal, A. C. Page, F. L. Pasley, R. Pearce, T. Porter, E. J. C. Reed, L. Reeves, W. A. R. Robertson, S. G. Squires, I. H. Strachan, W. K. Taylor, A. G. Ticehurst, F. W. D. Timson, F. W. Waddell, B. E. B. Walker.

Section C only (64).—K. G. Benham, E. F. Blackbourn, K. P. Brow, F. T. Bunclark, B.Sc. Eng. (Lond.), F. W. Butler, B.Sc. Eng. (Lond.), W. Butterworth, J. G. Campbell, J. A. Chippindale, L. Cleaver, B.Sc. (Wales), W. P. S. Cockle, B.Sc. Eng. (Lond.), E. C. Cookson, B.Sc. Eng. (Lond.), H. L. Copestake, N. Davey, B.Sc. Eng. (Lond.), C. G. Day, A. Dean, M.Sc. Eng. (Lond.), K. L. Forster, C. E. Gayes, M.Sc. (Leeds), O.W. Gilmour, B.A.I. (Dublin), W. H. Glanville, B.Sc. Eng. (Lond.), G. I. B. Gowring, B.Sc. Eng. (Lond.), H. J. B. Harding, B.Sc. Eng. (Lond.), P. C. G. Hausser, B.Sc. Eng. (Lond.), T. E. Hawksley, B.A. (Cantab.), W. H. Hillier, M.Eng. (Sheffield), J. L. Hunt, B.Sc. Eng. (Lond.), B. W. Huntsman, B.Sc. Eng. (Lond.), V. D. Joll, B.Sc. (Bristol), J. C. Jones, B.Sc. Eng. (Lond.), L. E. Jones, J. Kennard, B.Sc. Eng. (Lond.), R. P. Key, B.Sc.(Leeds), F. X. Koenig, E. B. J. Lanyon, H. F. Lea, E. G. Lee, B.Sc. Eng.(Lond.), W. G. Lees, B.Sc. (Birmingham), C. G. Lomax, K. G. H. Montgomery-Smith, B.Sc. Eng. (Lond.), C. C. Morley, B.Sc. (Birmingham), T. P. de S. Munasinghe, J. F. Pain, M.C., B.Sc. Eng. (Lond.), A. Peel, B.Sc. (Leeds), E. B. S. Powell, R. W. R. Powrie, B.Sc. (Edin.), H. Pughe-Evans, B.A. (Cantab.), W. E. Reed, E. H. Sale, B.A. (Cantab.), J. Sewell, A. B. Sharp, Junr., H. C. Sharpe, W. Sleight, B.Sc. (Leeds), H. L. Smith, A. Spence, G. H. Todd, C. B. Townsend, B.Sc. Eng. (Lond.), W. Urquhart, B.Sc. (Edin.), J. Verity, G. R. Walter, J. D. Watson, B.Sc. Eng. (Lond.), A. C. Webber, L. C. Whiskin, E. H. Wild, C. R. Wood, B.A. (Cantab.), H. Zaky, B.Sc. (Birmingham).

The results of the examinations held abroad will be announced later.

Andrew Carnegie Research Fund.—The Council of the Iron and Steel Institute is prepared to make annually a limited number of grants from the Research Fund founded by the late Mr. Andrew Carnegie in aid of metallurgical research work. The object of the scheme is not to facilitate ordinary collegiate studies, but to enable students, who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. Candidates, who must be under thirty-five years of age, must apply before the end of next February on a special form to be obtained from the secretary of the Institute. The value of the grant will depend on the nature of the proposed research work, but the maximum amount granted in any one year will, as a rule, not exceed £100. The payment of the grant will be made in four instalments, the first being payable on the announcement of the award and the remaining three payable quarterly, subject to receiving a report on the progress of the work either from the candidate or from his referees. The Council may, at its discretion, award a further grant in aid of any particular research work which seems to it sufficiently meritorious to justify further assistance.

Vickers Group Amateur Operatic Society.—It must be admitted that it is a plucky undertaking for an Amateur Dramatic Society to hire a full sized theatre for three nights, to give three representations of two of Gilbert and Sullivan's operas, to stage manage the whole affair, and provide an army of chorus singers, programme sellers and stewards, &c. Yet that is what the Vickers Group Amateur Operatic Society did last week in the new Scala Theatre, and it may be said at once that, with the co-operation of a kindred society, the Vickers Westminster Orchestra, it acquitted itself extraordinarily well. The operas chosen were "Trial by Jury" and "H.M.S. Pinafore," and they were listened to with great pleasure by a very numerous and appreciative audience, encores being very frequent. It would be impossible for us to attempt any detailed criticism of either acting or singing, but we can say that though the talent evinced was not quite equal throughout the caste, and though some of the voices had not quite body enough to fill the large theatre, the acting and singing, as a whole, were excellent, and in parts the listeners were treated to displays of true histrionic talent and delighted by really high quality singing. All through the Chorus was first class. We spent as thoroughly an enjoyable evening as we did when we saw the same Society play "Merrie England." We may add that the Society was formed in 1920 and was known until last year as "Vickers Westminster Amateur Operatic Society." The present title is, however, more appropriate, seeing that the members are drawn from the ranks of the staffs of the Metropolitan Vickers Company, Wolseley Motors, Ltd., and Vickers Boiler Company, as well as from Vickers House, and the works at Erith, Crayford, Dartford, &c.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	21/-
(1) Spanish	18/6
(1) N. African	18/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	20/6

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) Scotland—		
Hematite	3 18 6	—
No. 1 Foundry	4 0 0 to 4 2 6	
No. 3 Foundry	3 17 6 to 4 0 0	
N.E. Coast—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 8 0	3 8 0
Silicious Iron	3 8 0	3 8 0
No. 3 G.M.B	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 0	3 4 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 2 0	—
„ Forge	2 16 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 0 to 3 6 0	
Forge	3 2 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 6 0 (a); 4 8 6 (b); 4 13 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best „	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	11 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 10 0	—
Ship Plates, ½in. and up.	7 15 0	—
Sections	7 7 6 to 7 10 0	
Steel Sheets, under 3/16in. to ½in.	9 5 0 to 9 7 6	
Sheets (Gal. Cor. 24 B.G.)	—	17 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	7 5 0	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†..	—
Light „	8 5 0 to 8 10 0	
Billets	7 10 0 to 10 10 0†	
Manchester—		
Bars (Round)	8 5 0 to 9 0 0	
„ (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	8 0 0 to 8 5 0	
„ (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
Midlands—		
Small Rolled Bars	7 15 6 to 8 0 0	
Billets and Sheet-bars	6 2 6 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 12 6 to 16 15 0	
Angles	7 2 6 to 7 7 6	
Joists	7 2 6 to 7 7 6	
Tees	8 2 6 to 8 7 6	
Bridge and Tank Plates	7 15 0 to 8 0 0	
Boiler Plates	11 0 0 to 12 0 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/9 to 20/3
Block Tin (cash)	282 10 0
„ (three months)	278 10 0
Copper (cash)	60 0 0
„ (three months)	61 0 0
Spanish Lead (cash)	36 0 0
„ (three months)	35 8 9
Spelter (cash)	39 10 0
„ (three months)	38 7 6
Manchester—	
Copper, Best Selected Ingots	65 10 0
„ Electrolytic	67 10 0
„ Strong Sheets	92 0 0
„ Tubes (Basis Price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	38 5 0
„ Foreign	37 0 0

FERRO ALLOYS.

(*All prices now nominal.*)

Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/8 to 1/9 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	8/-
„ 6 p.c. to 8 p.c. „	£23 0 0	7/9
„ 8 p.c. to 10 p.c. „	£22 10 0	7/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£40 0 0	15/-
„ „ 1 p.c. „	£51 0 0	17/-
„ „ 0.70 p.c. carbon	£56 10 0	19/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	3/9 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
„ „ 75 p.c.	£21 0 0 scale 6/- per unit	
„ Vanadium	16/- per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £177	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/9
„ „ Ell	15/4½
„ „ Splint	16/6 to 18/-
„ „ Trebles	17/3
„ „ Doubles	16/6
„ „ Singles	14/3
Ayrshire—	
(f.o.b. Ports)—Steam	14/9
„ „ Splints	16/6
„ „ Trebles	17/3
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 15/1½
Screened Navigation	20/9
Trebles	18/- to 19/-
Doubles	16/9
Singles	14/6
Lothians—	
(f.o.b. Leith)—Best Steam	15/-
Secondary Steam	14/4½
Trebles	18/-
Doubles	16/9
Singles	14/6

ENGLAND.

	Inland.	Export.
(8) N.W. Coast—		
Steams		23/6
Household		40/- to 45/-
Coke		25/-
Northumberland—		
Best Steams		15/6
Second Steams		14/6
Steam Smalls		10/- to 10/3
Unscreened		14/-
Household		20/- to 22/-
Durham—		
Best Gas		16/- to 16/6
Second		14/6 to 15/-
Household		20/- to 22/-
Foundry Coke		20/- to 22/6
Sheffield—		
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	24/- to 26/6	—
„ „ House	23/- to 25/-	—
„ „ Large Nuts	17/- to 20/-	—
„ „ Small	12/6 to 14/-	—
Yorkshire Hards	16/6 to 19/6	—
Derbyshire „	16/6 to 19/-	—
Rough Slacks	9/6 to 12/6	—
Nutty „	6/6 to 7/6	—
Smalls	3/6 to 5/6	—
Blast-furnace Coke (Inland)*	—	—
„ „ (Export)		f.o.b. 17/9 to 18 3

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	23/- to 23/6
Second „ „	21/- to 22/6
Best Dry Large	22/6 to 24/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	19/6 to 20/6
Western Valley „	19/- to 19/6
Best Eastern Valley Large	19/- to 19/6
Ordinary „ „	18/9 to 19/-
Best Steam Smalls	11/6 to 12/6
Ordinary „	9/- to 10/6
Washed Nuts	19/- to 29/6
No. 3 Rhondda Large	26/- to 28/6
„ „ Smalls	14/6 to 15/-
No. 2 „ Large	18/6 to 19/6
„ „ Through	16/6 to 17/6
„ „ Smalls	10/- to 10/6
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/6 to 22/6
Pitwood (ex ship)	31/- to 32/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/- to 42/6
Seconds	32/6 to 37/6
Red Vein	28/- to 32/6
Machine-made Cobbles	57/6 to 60/-
Nuts	57/6 to 60/-
Beans	42/- to 43/6
Peas	21/- to 25/-
Breaker Duff	6/9 to 7/3
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	22/- to 23 6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/6 to 17/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/6, with fluctuations according to analysis; open market, 17/- to 18/6 at ovens. † Latest quotations available (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Engineer's Status.

A Congress has been held at the Conservatoire des Arts et Métiers in Paris, under the designation of the "Engineer's Week," the object of which was to examine the situation of the engineering profession and decide upon measures to be adopted for raising its status. It is intended that it shall be the first of a series of Congresses which will deal with all questions affecting the work and position of the engineer. Some such organisation has become a pressing necessity in view of the entire absence of any central authority which can exercise a control over the granting of diplomas and can ensure a recognition of the professional value of a qualified engineer. Apart from the Polytechnique, the Ecole Centrale, the Arts et Métiers, and a few other State and semi-State institutions, the diplomas of which are guarantees of the professional capacity of those possessing them, there is a considerable number of private schools of a commercial character which train pupils for the engineering profession and deliver diplomas that are supposed to enable them to occupy responsible positions. The new schools created during the past few years are turning out so many engineers, that the number is far in excess of requirements. There has consequently been a lowering of the engineer's status, and the salary he receives is often not much more than the wages paid to the men under his control. Many engineers have to content themselves with subordinate positions in the works. That does not apply, as a rule, to former pupils of the big institutions whose diplomas are taken at their proper value by employers, and as the former pupils of each institution are grouped together in an association which looks after their interests, the engineer whose qualifications are recognised has little reason to complain. The trouble lies more particularly in the considerable number of engineers leaving the smaller schools, and the struggle for situations is having such a demoralising effect that the only remedy seems to be to deter parents from regarding engineering as a remunerative profession, unless their sons are talented for the work. The Congress presented suggestions for improving the condition of engineers, and they will doubtless be developed at future meetings.

Marseilles Harbour Extensions.

Having practically completed the canal to the Rhone at Arles by the construction of the Rove tunnel, which is of itself one of the biggest undertakings of the kind yet carried out, and converted the Etang de Berre into a port capable of providing wharves and anchorage for a vast commercial fleet, principally in view of the future traffic by the Rhone and of the coal, oil and other shipping which is to be diverted away from the town, the Marseilles Chamber of Commerce has decided to put in hand another programme which is destined to permit of the port of Marseilles itself keeping pace with the growing North African traffic. Notwithstanding the considerable extensions of basins as far as L'Estaque, it is believed that, in course of time, the North African traffic will far outstrip the present accommodation, and there is the further drawback that in bad weather it is often difficult for vessels to enter the port. It has therefore been decided to construct an outer port, known as the Pharo, with three moles which will allow of fifteen boats of the dimensions of those now running between Marseilles and North Africa berthing alongside, while the railway will be extended down to the landing stages. The old Joliette basin is also to be enlarged. Practically the whole of the cost of carrying out the vast works for making Marseilles one of the largest and best equipped ports of the world, which were started upon fourteen years ago, has been defrayed by the Chamber of Commerce, for while the State undertook to participate in the expense it has not yet been able to contribute its share.

West African Railways.

The opening up of West Africa has been pursued less actively than the development of other colonies, for the reason principally that the population is widely disseminated and is generally too primitive and too indolent to be utilised for manual work. Nevertheless, it is believed that this vast territory is as fertile and valuable as the adjoining Belgian Congo, from which all kinds of produce are sent to Belgium in considerable quantities, as well as diamonds, gold and copper. While in the Belgian Congo the railway system has been developed on a very large scale with the aid of the six milliard francs already invested in the colony, and will be still further extended with another milliard which is to be raised shortly for colonial expansion, the French have so far devoted very little to railway construction in West Africa. The traffic over the Belgian railways is so heavy that the French are unable to make sufficient use of them for the transport of produce from their adjoining colony, and since Parliament voted some of the credits necessary for the construction of the railway between Brazzaville and the port of Pointe-Noire, the work has been carried on actively, with the result that 100 kiloms. of line have been completed and 290 kiloms. are well advanced. The line has a 3ft. 6in. gauge, and easy gradients are provided by the construction of a large number of tunnels. Plans are now being prepared for enlarging and equipping the port of Pointe-Noire.

Moving Platforms.

The trials of moving platforms which were carried out at Belleville, near Paris, have now been completed, and a Commission is preparing a report for the Municipal Council upon the feasibility of laying down experimental platforms under one of the leading thoroughfares. On the whole, it does not appear as if the two systems tested have given general satisfaction. The trials were followed throughout by M. Pierron, Professor of Psychology of Sensations at the Collège de France, who declares that a platform providing a sufficient gradation of speeds up to 15 kiloms. an hour should have a width of at least 31 m.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

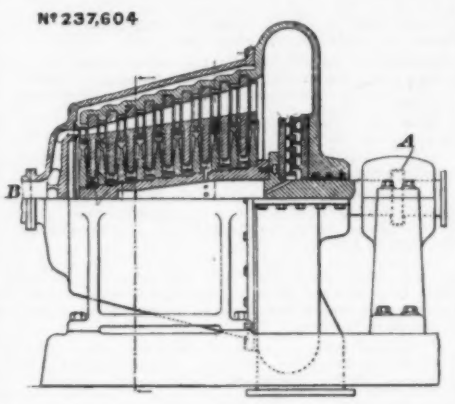
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

237,604. July 20th, 1925.—High-pressure Steam Turbines, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

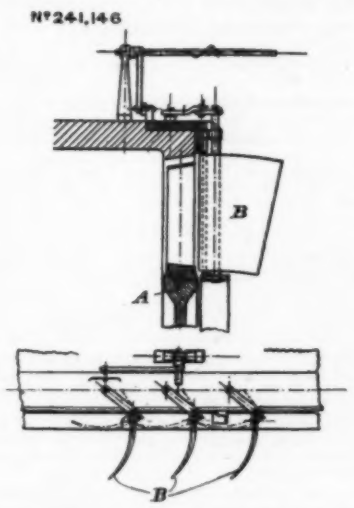
This turbine is intended for working at steam pressures of the order of 1000 lb. per square inch or more, and the chief peculiarity lies in the fact that the rotor is entirely overhung, beyond



the bearing A, so that packing at the high-pressure inlet end B is unnecessary. The rotor is also stepped in diameter, as shown in the drawing, to reduce end thrust as far as is possible. The turbine, it will be seen, is of the impulse type.—*October 15th*, 1925.

241,146. August 29th, 1925.—Reversing Steam Turbines. H. Boltshauser, 19, Hardturmstrasse, Zurich, Switzerland.

This invention is intended to reduce the losses caused in a steam turbine fitted with a reversing set of blading, through the windage of the reverse blades when the machine is going ahead.



Behind the reversing disc A there is arranged a series of hinged blades or shutters B B, which are pivoted to the fixed part of the turbine. These shutters can be swung into the position shown by the dotted lines, when the reverse turbine is not working, and then, it is claimed, the desired result is produced.—*October 15th*, 1925.

DYNAMOS AND MOTORS.

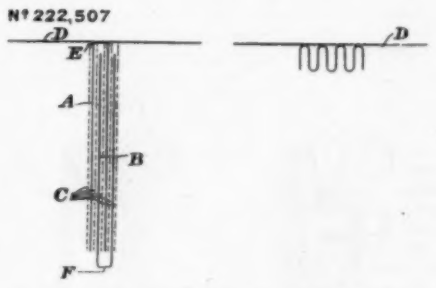
220,931. August 23rd, 1923.—Improvements in or relating to Electric Driving Mechanism for Weaving, Knitting, and like Machines, Siemens-Schuckertwerke Gesellschaft mit beschrankter Haftung, of Siemensstadt, near Berlin, Germany.

The rotor of the variable-speed motor described in this specification is provided with two separate windings, one connected to slip rings and resistances, and the other is short circuited. The pole changing is not bound to be in the ratio of 1 : 2, but the windings may be graded or stepped in relation to each other so that other proportions in the number of revolutions can be obtained. The left-hand drawing shows the rotor arranged for the low number of poles and the right-hand diagram the high number of poles or low number of revolutions. The full lines represent the operative winding, whilst the dotted lines represent the inoperative winding. The winding A is connected to slip rings, whilst the winding B is short circuited. After changing the number of stator poles and the corresponding field is produced in the rotor, the rotor winding corresponding to the number of stator poles becomes operative. When the number of poles is low and the number of revolutions consequently high the speed may be adjusted by means of the resistances, while with the relative large number of poles and low speed of revolutions the working winding is short circuited as shown.—*October 12th*, 1925.

TELEGRAPHS AND TELEPHONES.

222,507. September 25th, 1924.—Improvements in or relating to Electric Condensers, Dr. H. C. Hermann Meusser, of 20, Prinz Friedrich Leopoldstr, Berlin Nikolassee, Germany.

This invention relates to a condenser for receiving or transmitting sound by the conversion of variations of motion into variations of electrical capacity or *vice versâ*. A and B are two sets of foils which are insulated from one another by elastic material C. D denotes the diaphragm, which is connected with the condenser A, B, and C at only one point or end, where there

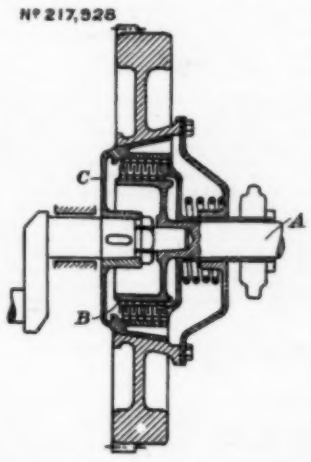


is a conducting wire E that pertains to one set of the foils. F is the conducting wire associated with the other set of foils. The sound transmitted to the condenser by the diaphragm is spread over the entire area of the condenser by the sound-conducting properties of the foils A and B. The diagram on the right shows a modified form of construction in which the condenser, composed of sheets of foils and intermediate elastic insulating layers are bent to form undulations which are acted upon by the diaphragm D in the manner shown. It will be understood that the thick undulated line represents the complete condenser.—*October 15th*, 1925.

TRANSMISSION OF POWER.

217,928. June 21st, 1923.—Apparatus for Damping the Oscillations of Fly-wheel and like Shafts, Oesterreichische Daimler Motoren Aktiengesellschaft, of Wiener Neustadt, Austria.

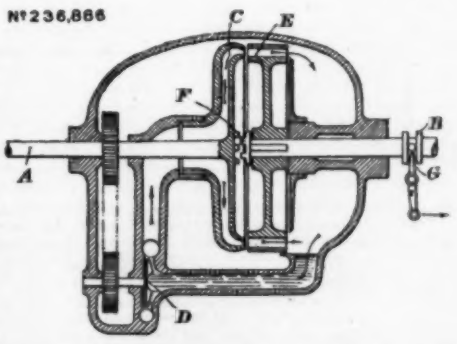
The object of this invention is to damp the oscillations of



crank and similar shafts. The crank shaft is coupled to the driven shaft A by means of a multiple disc clutch B, which is connected to the fly-wheel by means of a flexible coupling, consisting of a coned member C fitting into a coned surface in the fly-wheel.—*September 23rd*, 1925.

236,886. January 13th, 1925.—Change Speed Gear, L. Renault, 15, rue Gustave Sandoz, Billancourt (Seine), France.

In the place of the usual gear-box of a motor car the inventor proposes to use a form of hydraulic transmission. In the drawing A is the driving shaft and B the driven. On the driving shaft there is an impeller C, which is supplied with liquid from the

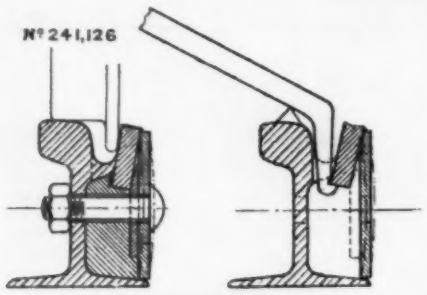


bottom of the casing by the centrifugal pump D. This pump is driven by chain gearing as shown. The jets issuing from the orifices of the impeller impinge on the vanes of a turbine wheel E fixed on the driven shaft, and consequently rotate the latter, provided that its resistance is not too great. Arrangements are made at F and G for positively locking together the two shafts.—*October 15th*, 1925.

TRAMWAYS AND RAILWAYS.

241,126. May 23rd, 1925.—Grooved Rails, "Phœnix" Aktien-Gesellschaft für Bergbau und Hüttenbetrieb, Abtielung Ruhrort, Phœnixstrasse No. 7, Duisburg-Ruhrort, Germany.

Where a grooved rail track, *e.g.*, of a tramway, is laid on a curve the wear on the check is comparatively large, so that it is an advantage if the check can be made renewable. It should be possible to renew it without breaking up the street; the renewable check should be of a usual form such as can be cheaply rolled, *e.g.*, of a simple flat section, and must be capable of being securely fastened in the track; and finally, its fastening should not require special means, such as wedges or the like. It is the purpose of the present invention to meet these requirements. According to the invention a check, preferably of flat rectangular cross section, is forced down between a checkless grooved rail and a retaining plate separated from the rail by filling blocks, the check standing at an angle with its inner surface against a coned surface on the rail at the part which is ordinarily the root of the check and its outer surface against the retaining plate, and resting upon the filling blocks. The flat steel strip is bent

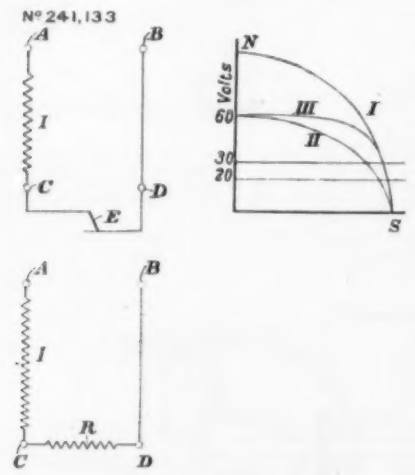


to the curve of the track, and when driven into position takes the form of a segment of a frustrum of a cone, which co-acts with the conical surface of the grooved rail wedge fashion, so that there is no possibility of the check springing out under the wheel pressure of a tram, even if the check is not otherwise secured in the track. But the check can be forcibly pulled out from the track and exchanged for a new one when wear necessitates renewal. The exchange leaves the street surface undisturbed since the old check is pulled out and the new one forced in from above. Since the flat steel strip must be twisted as it is driven in, it is desirable definitely to guide it so that it seats firmly on the conical surface of the rail. The invention attains this result by the provision of a bevelled guide plate between the filling blocks and the retaining plate, the bevelled edge forming a slanting guide surface for the check. The check may be more firmly seated by bevelling the upper inner edge of the retaining plate on which it bears to an angle corresponding with the slant of the check, so that the area of contact is wider. To facilitate the lifting out of the check the bottom of the rail groove or root of the check is recessed between successive filling blocks to admit a kneed crow-bar.—*October 15th*, 1925.

WELDING.

241,133. October 15th, 1925.—Improvements in the Automatic Voltage Regulation of Alternating-current Circuits, particularly for Welding Machines, *John James Victor Armstrong, of* 12, *Church-street, Liverpool.*

This invention relates to an arrangement for reducing the voltage of the load terminals of an alternating-current electric supply system at no load without interfering with the value of this voltage under load conditions. The terminals A and B of the circuit shown are connected to a supply of about 100 volts. The terminals of the welding circuit are shown at C and D, E being the electrode. I is an impedance giving the pressure drop necessary for stabilising the arc. When resistances of different values are connected between the terminals C and D and the current in these resistances and the voltage between the ter-



minals are measured and plotted, a curve as shown at I in the right-hand illustration may be obtained, S being the short circuit point and N the no-load point. The voltage at the latter point is 100. This characteristic is very suitable for feeding the electric arc, as in the zone of the load voltage 20–30 volts the current is nearly constant for different voltages. If a pressure of 60 volts is applied between the terminals A and B the voltage between the terminals C and D at no load would also be 60 and the current voltage characteristic would be given by the curve II. This characteristic is not so good in the working zone 20–30 volts as the characteristic No. 1. According to this invention, a reduction of the no-load pressure between the terminals C and D can be obtained without interfering with the form of the characteristic I in the load zone by inserting a suitably designed R reactance between the load terminals C and D. By giving the magnetic circuit of this reactance a suitable saturation value the characteristic III may be obtained. In the load zone 20–30 volts this characteristic III is the same as I, as the current in the reactance is then negligible. At no load, however, the current in the reactance is much higher, as the saturation of the magnetic circuit is high, and therefore a considerable pressure drop in the ractance I is obtained, this causing a reduction in the voltage between the terminals C and D.—*October 15th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Marine Engineers.—Shipping, Engineering and Machinery Exhibition, Olympia, London, W. "Salvage Operations," by Sir F. W. Young. 6.30 p.m.

Institution of Automobile Engineers.—Shipping, Engineering and Machinery Exhibition, Olympia, London, W. Special Marine Conference. Papers: "The Installation of Small Marine Motors," by Mr. C. H. Macmillan; "The Advantages of Twin-screw Installations for Motor Boats," by Mr. Basil H. Joy. 11 a.m.

Institution of Electrical Engineers: South Midland Centre.—Grand Hotel, Birmingham. Annual dinner. 7 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. On account of the funeral of the late Queen Alexandra the Informal meeting arranged for this evening will not be held.

Institution of Production Engineers.—Society of Motor Manufacturers and Traders, 83, Pall Mall, London, S.W. 1. Paper, "Fundamentals of Jig and Special Purpose Machine Design, with Special Reference to Automobile Manufacture," by Mr. E. W. Hancock. 7.30 p.m.

Physical Society of London.—Imperial College of Science, Imperial Institute-road, South Kensington, London, S.W. 7. Papers: "Atomic Dimensions," by Mr. R. G. Lunnon; "On Edge Tones" (I.), by Mr. W. E. Benton; "The Spectroscopic Detection of Minute Quantities of Mercury," and "On the Storage of Small Quantities of Gas at Low Pressures," by Mr. J. J. Manley; demonstration of "An Instrument for Imitating the Eastward Deviation of Bodies Falling from a Great Height," by Mr. G. R. Mather. 5 p.m.

SATURDAY, NOVEMBER 28TH.

Institution of Automobile Engineers.—London Graduates' visit to works of S. Smith and Sons, Ltd., Cricklewood. 2.30 p.m.

Junior Institution of Engineers.—Visit to the Shipping, Engineering and Machinery Exhibition at Olympia. Lecture, "Introspection as an Aid to an Industrial Revival," by Mr. T. E. Dimbleby. 3 p.m.

MONDAY, NOVEMBER 30TH.

Bradford Engineering Society.—Technical College, Great Horton-road, Bradford. Lecture, "Water Meters," by Mr. H. W. Swift. 7.30 p.m.

Institution of Locomotive Engineers: Manchester Centre.—College of Technology, Sackville-street, Manchester. Paper, "Vacuum Brake Ejectors," by Mr. J. N. Gresham. 7 p.m.

Railway Club.—65, Belgrave-road, London, S.W. 1. Paper, "Railway Grouping and Economics," by Mr. B. M. Bagley. 7.30 p.m.

TUESDAY, DECEMBER 1ST.

Institute of Marine Engineers.—Shipping, Engineering and Machinery Exhibition, Olympia, London, W. "Motor Ship Progress in 1925," by Mr. A. C. Hardy. 8 p.m.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Discussion on "The Production of Sound Ingots." 7 p.m.

Institute of Metals: North-East Coast Local Section.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Paper, "The Solidification of Metals," by Dr. Maurice Cook. 7.30 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Requirements of the Military Motor Vehicle," by Captain R. K. Hubbard. 7 p.m.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Some Notes on Service," by Mr. G. H. Day. 7.15 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Paper, "Trafford Wharf Reconstruction at the Manchester Docks," by Mr. H. A. Reed. 6 p.m.

WEDNESDAY, DECEMBER 2ND.

Institution of Automobile Engineers.—Cavendish Café, Cornmarket, Derby. Derby Graduates' meeting. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Students' meeting. Paper, "Escalators on the Central London Railway," by Mr. H. F. Molony. 6 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "The Performance of Amplifiers," by Mr. H. A. Thomas. 6 p.m.

Institution of Heating and Ventilating Engineers.—Shipping, Engineering and Machinery Exhibition at Olympia, London, W. Paper, "The Requirements of Ablutionary and Recreative Bathing Establishments as Affecting the Heating and Ventilating Engineer," by Mr. J. E. Boaz. 7.30 p.m.

Institution of Sanitary Engineers.—Visit to the Shipping, Engineering and Machinery Exhibition at Olympia. Paper, "Garbage Reduction Processes," by Mr. G. M. Flood. 4.30 p.m.

Institution of Electrical Engineers: South Midland Centre.—The University, Edmund-street, Birmingham. Paper, "An All-electric House," by Dr. S. Parker-Smith. 7 p.m.

THURSDAY, DECEMBER 3RD.

Institution of Civil Engineers: Yorkshire Association.—Hotel Metropole, Leeds. Paper, "Waterworks Construction," by Mr. Colin Clegg. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "An All-electric House," by Dr. S. Parker-Smith. 6 p.m.

FRIDAY, DECEMBER 4TH.

Institution of Water Engineers.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers: "Recent Studies Relating to the Purification of Water, and the Action of Various Waters on Lead and Copper Pipes," by Dr. John C. Thresh and Mr. John F. Beale; "Further Observations on the Biology of Jersey Waterworks," by Dr. W. Rushton and Mr. P. A. Aubin; "An Analysis of Scottish Rainfall Records," by Mr. W. N. McClean; "The Afforestation of Watersheds," by Lieut.-Colonel J. R. Davidson. Lecture, "The London Water Supply," by Mr. H. E. Stilgoe. 10.30 a.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Super-heterodyne Reception," by Mr. A. E. Bowyer-Lowe. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. "Transmission of Power—the Present and the Future," by Mr. G. Constantinesco. 7.30 p.m.

SATURDAY, DECEMBER 5TH.

Institute of British Foundrymen: Birmingham, Coventry and West Midlands Branch.—Lecture Room of Pooley and Sons, John Bright-street, Birmingham. "The Melting and Pouring of Brass and Bronze," by Mr. T. J. Bamford. 6 p.m.

Institution of Civil Engineers.—Students' visit to the stations and escalator tunnels of the City and South London Railway extension to Morden.

MONDAY, DECEMBER 7TH.

Institution of Automobile Engineers.—The College, Loughborough. Loughborough Graduates' meeting. 7 p.m.

TUESDAY, DECEMBER 8TH.

Institute of Marine Engineers.—85-88, The Minories, Tower Hill, London, E. 1. "Powdered Fuel Developments," by Mr. M. L'Herminier. 6.30 p.m.

Institution of Automobile Engineers: Coventry Centre.—Broadgate Café, Coventry. General meeting. 7.30 p.m.

WENDESDAY, DECEMBER 9TH.

Institution of Engineers-in-Charge.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper, "Oil Fuel for Commercial Purposes," by Mr. J. V. Stevens. 7.30 p.m.

Radio Society of Great Britain.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting. Talk on "The Acoustics of the Headphone and Loud Speaker," by Mr. A. E. Bawtree. 6 p.m.

THURSDAY, DECEMBER 10TH.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85-88, The Minories, London, E. 1. Joint meeting with the Institution of British Foundrymen. Paper, "Commercial Aluminium Alloys from the Users' Point of View," by Mr. J. B. Hoblyn. 7.30 p.m.

FRIDAY, DECEMBER 11TH.

Institute of Metals: Sheffield Local Section.—Applied Science Department, The University, St. George's-square, Sheffield. Paper, "Nickel Silver," by Professor F. C. Thompson. 7.30 p.m.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Paper, "Modern Metallurgy," by Professor J. H. Andrew. 7.15 p.m.

Railway Club.—65, Belgrave-road, London, S.W. 1. Paper, "Some Little Known Features of Railway Publicity," by Mr. J. R. Hind. 7.30 p.m.

MONDAY, DECEMBER 14TH.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Aluminium and its Alloys as Used for Engineering Purposes," by Dr. H. Hyman. 7.30 p.m.

EDUCATIONAL INTELLIGENCE.

Two "Charles R. E. Bell Fund" Senior Travelling Scholarships, to the value of £150 each, and two "Charles R. E. Bell Fund" Junior Scholarships, to the value of £60 each, will be awarded on the results of the examinations conducted by the Commercial Education Committee of the London Chamber of Commerce in February, 1926, and in April-May, 1926. To qualify for the Senior Travelling Scholarships candidates must pass the Chamber's senior examination in one foreign language and the Chamber's senior examination in English. To qualify for the Junior Scholarships candidates must pass the Chamber's examination for the full junior certificate. Full details of these examinations may be obtained from the Principal, Commercial Education Department, London Chamber of Commerce, 97, Cannon-street, London, E.C. 4.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Alexr. Chaplin and Co., Ltd., of Cranstonhill Engine Works, Helen-street, Govan, Glasgow, asks us to announce that they have appointed the Harvie Corporation, Ltd., of Broadway Buildings, Westminster, London, S.W. 1, as their sole representatives for the London area.

The Council of the Royal Meteorological Society has awarded the Symons Gold Medal for 1926 to Lieut.-Colonel Ernest Gold, D.S.O., F.R.S., Assistant Director of the Meteorological Office. The medal is awarded for distinguished work in connection with meteorological science, and will be presented at the annual general meeting on January 20th.

CONTRACTS.

James Pollock, Sons and Co., Ltd., 3, Lloyds-avenue, London, E.C. 3, have received instructions to supply a 10 brake horse-power Bolinder engine of the latest type, to be installed in a boat now being built by Bushell Brothers, of Tring, for a firm of paper manufacturers which have several mills situated on the Grand Junction Canal.

The Dublin Dockyard Company (Vickers-Ireland, Ltd.) has received an order to construct a tug and pilot vessel from the Bluff Harbour Board, New Zealand. The dimensions of the vessel will be 135ft. by 30ft. by 20ft., and she will be fitted with twin-screw hot-bulb engines, by Vickers-Petters, Ltd., designed to develop 1200 brake horse-power. Her speed on service is to be 12 knots.

The Bristol Docks Committee has placed an order with the Engine Works Department of Sir W. G. Armstrong, Whitworth and Co., Ltd., for a pair of steel gates for the Avonmouth Dock. The entrance to the dock is 80ft. wide and the gates, which will be of the buoyant type, will weigh over 300 tons. It is interesting to note that the same firm has under construction at the present time eleven pairs of gates for various docks in this country.

A Seven-Day Journal

Electricity Supply.

ACCORDING to the Electricity Commissioners' fifth annual report, which has just been issued, the aggregate capacity of the generating plant for new stations and extensions of existing stations sanctioned by the Commissioners during the year 1924–1925 amounted to approximately 480,000 kilowatts. The rate of provision for meeting the growing demands upon electricity undertakings was thus fully maintained at the figure recorded for the preceding year, notwithstanding the continuance of the industrial depression. Of the 2,244,226 kilowatts of generating plant sanctioned during the past five years, 426,683 kilowatts, or approximately 19 per cent., was for new stations, and 1,817,543, or 81 per cent., for the purpose of extending or remodelling existing generating stations. During the year ending March 31st, 1925, the Commissioners issued twelve consents, six to authorised undertakers and six to non-statutory undertakings, in respect of the establishment of new generating stations, representing the initial installation of plant having a total rated capacity of 16,681 kilowatts. As in the preceding year, the Commissioners dealt with a number of important applications for consent to the establishment of main transmission lines for the purpose of further developments in conformity with the schemes of reorganisation for various districts and for the giving and taking of bulk supplies. A number of these consents related to 33,000-volt transmission lines and two to 66,000-volt lines, the respective undertakers in the latter cases being the County of Durham Electric Power Company and the North Wales Power Company, Ltd.

New Shipbuilding Orders for the Wear.

WITH the close of last month some welcome shipbuilding orders for Wearside were made known. It is announced that the Silver Line, Ltd., which has been granted from the Treasury a guarantee of £1,107,000 under the Trade Facilities Acts for the construction of the vessels, has placed with J. L. Thompson and Sons, Ltd., and Sir James Laing and Sons, Ltd., both of Sunderland, an order for three motor cargo vessels each. The new ships will be 13-knot vessels of about 9000 tons deadweight carrying capacity and will be propelled by Doxford opposed piston marine oil engines, built by William Doxford and Sons, Ltd., of Sunderland. Another Sunderland firm, the Sunderland Forge and Engineering Company, Ltd., is to supply the auxiliary machinery that will be required. The order, it may be remarked, is one of the largest ever booked on Wearside. We learn that the new ships, when they are completed, will be employed on a service between New York and the Far East, which is now being conducted by the six existing ships belonging to the company. Almost at the same time Wm. Pickersgill and Sons, Ltd., of Sunderland, announced that an order had been placed with them by Cairns, Noble and Co., of Newcastle-on-Tyne, for a cargo vessel of 7700 tons deadweight capacity, the turbine propelling machinery of which is to be built by the Parsons Marine Steam Turbine Company, Ltd., of Wallsend.

Power Alcohol.

AFTER investigating every means of providing a home-produced fuel which can be conveniently substituted for imported petrol the French still believe that the final solution lies in the utilisation of alcohol. The hydrogenation of coal may eventually provide considerable supplies of liquid fuel, and the use of charcoal for gas production will, it is held, certainly undergo a great extension; but despite the failures to enforce the use of alcohol for power purposes in any shape or form, the fact of its possible production being practically unlimited has induced the French to give further attention to this fuel. The attempt to compel motor car users to employ a mixture of alcohol and petrol failed because such a mixture was not practicable without a previous dehydration of the alcohol, which necessarily further increased the already high price of the spirit, and it is now recognised that alcohol can only be employed in the pure state in engines specially designed for its consumption. There is no doubt, it is held, that for most purposes the inconvenience attending the use of alcohol, such as the difficulty of starting engines cold, are more than balanced by the greater efficiency obtained with much higher compression pressure in special engines, although such compressions and the extra weight of the engines would certainly limit the employment of alcohol for motor vehicles. At the same time, it is argued there can be no prospect of any real advance being made in the designing of alcohol engines until manufacturers are assured of a plentiful and cheap supply of the fuel. The only hope of procuring abundant supplies lies in the production of alcohol from colonial produce, and experts are now being sent by the French Government to West Africa to investigate the possibility of creating a vast alcohol industry. To a large extent they will go over ground that has already been covered by other commissions, which came to the conclusion that the labour scarcity in the African Colonies would not permit of alcohol being produced at a sufficiently low cost. Since then the price of petrol has increased so considerably that the chances of producing alcohol to compete with it have certainly improved.

Completion of a Submarine.

SUBMARINE L 27, the last but one of the boats ordered during the war, was commissioned for trials at Sheerness on Tuesday last, December 1st. Laid down in the Vickers yard at Barrow in January, 1918, she was eventually towed to Sheerness Dockyard to have her machinery installed, and has now been completed after nearly eight years of leisurely work. The "L" class, of which she is a unit, is regarded as the finest group of patrol submarines in service under any flag. The L 27 displaces 890 tons on the surface and 1080 tons when submerged, her length overall being 238½ft. Motive power for surface cruising is provided by two sets of twelve-cylinder Vickers type solid injection engines, developing 2400 brake horsepower for 17½ knots. The armament consists of one 4in. gun and four torpedo tubes. The final submarine of the war programme, L 26, which was also begun in January, 1918, is not to be completed until October next, and will thus have been nearly nine years under construction. Some interesting figures relative to the cost of British submarines were given by the Admiralty in answer to a question in Parliament last week. They show that the total expenditure incurred in building submarines from the financial year 1902–03 to March 31st of the current year was £46,800,348. The cost of repairs during the same period was roughly £5,700,000. The annual cost of maintenance, including *personnel*, of all submarines at present in commission is approximately £1,378,000.

Overseas Visitors to Olympia.

ON the evening of Tuesday, the 1st, a dinner was given to the overseas visitors to the Shipping, Engineering and Machinery Exhibition at Olympia by Mr. F. W. Bridges, the organiser of the show, and the meeting soon produced a happy interchange of opinion and experience. Sir Charles A. Parsons was in the chair, and in his address emphasised the value of the work which is being carried on by metallurgists in the way of helping engineers to attain their ideals. In this connection he mentioned the steels recently invented which would enable steam engineers to adopt much higher pressures than those heretofore used, and thus produce prime movers that would work at efficiencies comparable with those of internal combustion engines. The most interesting speech of the evening was, however, that of Mr. J. Butler, a member of the executive of the Dominion Federated Sawmillers' Association, Wellington, New Zealand. Mr. Butler passed lightly over the difficulties which overseas buyers have in persuading British manufacturers to supply them with what they precisely want, and went on to point out that had it not been for the perfection of modern steamships, which carried frozen mutton from his country—of adoption—to England, New Zealand would never have attained to its present importance. He had, he said, recently come across the Channel by aeroplane, and during the voyage had made a mental calculation which showed that, weight for weight, the passengers in the aeroplane were carried more cheaply than were the logs in a forest moved by an "air line" or overhead ropeway. Dr. Hele-Shaw emphasised the advance which has been made within recent times by the substitution of autogenous welding for riveting. Captain Stevenson (Australia) referred to the early days of submarine warfare, and Mr. D. A. Bremner (British Engineers' Association) gave some statistics indicating that the trade of this country is in a better position than many pessimists would allow. Brig.-General Mowatt briefly proposed the toast of "Our Guests from Overseas," which was responded to by Mr. F. W. Watson (South Africa), and "The Chairman" was proposed by Sir John A. Cockburn.

The Difficulties of British Railways.

BRITISH railways at the present moment are in a position of sufficient difficulty without being called upon to resist attacks both from above and below. At one end of the scale there is the demand of the men for a national increase of wages. This programme, now before the National Wages Board, would, if given effect to, involve an additional annual expenditure of at least forty million pounds. Dealing with the subject during last week-end, Mr. J. H. Thomas remarked to an audience of railwaymen that if the dividends of all the ordinary shareholders were wiped out and all the railway officials were dismissed the companies would still have insufficient money to meet the demand. It was not practicable, he added, to increase the rates, to threaten to strike would do incalculable harm, and to talk about nationalisation as a simple cure of the trouble was futile. At the other end of the scale the railways were attacked last Thursday in the House of Lords by Lord Monkswell for failing to remove some serious defects reacting upon the convenience and safety of the public. He asked the Government to urge upon the railways the immediate adoption of certain improvements. Lord Montagu, who claimed to be the only member of the House who had had practical footplate experience in this and other countries, stoutly defended the railways against Lord Monkswell's accusation that they were averse from progress or the adoption of new inventions or that they compared unfavourably with foreign railways. Lord Banbury, Lord Knaresborough, and Viscount Churchill, as railway directors, also refuted the accusation, and Viscount Peel, replying for the Government, expressed the view that it was an inopportune time to press the railways to adopt improvements and to provide additional facilities.

Shipbuilding in Germany.

IN spite of the relatively large number of ships built in Germany during the year, the present position of the shipbuilding industry in that country is one which is causing a considerable amount of anxiety. Although German shipbuilding firms have the advantage of lower labour costs and are free to a large extent from vexatious trade union restrictions, it is admitted that some recent orders are only being carried through at a loss. With a view to cutting down expenses and pooling orders, efforts have recently been made in the direction of forming a combine, but so far this development has not passed the initial stages. With a view to meeting the distress prevalent in the industry it is reported that Blohm and Voss, of Hamburg, have decided to lay down on their own account a liner of approximately 30,000 gross tons. An order is expected to be received in due course from the Hamburg-American Line for this ship, but its actual placing has been delayed for a time by the negotiations in America for new capital to the extent of about £2,000,000, which have yet to be concluded. It is not known whether the new liner will be propelled by marine oil engines or geared turbines.

The Dolgarrog Disaster.

ON Tuesday the North Carnarvonshire coroner, sitting with a jury, concluded the inquest on the eleven victims of the recent failure of the Eigiau Dam. The evidence submitted showed that the dam was constructed in two sections, the first having been completed about two years before the second was begun, and that the disaster had its origin at or very close to the point of junction of the sections. Mr. Ralph Freeman, a partner in the firm of Sir Douglas Fox and Partners, consulting engineers, stated that when the burst took place a section of the clay below the dam measuring about 60ft. long by 12ft. deep was washed out, the upper part of the wall remaining intact. On measuring the form of the dam as it stood at the ends of the opening he had found that at one end the dam had been carried only 1ft. 6in. into the clay, while at the other end the depth was 6ft. The structure in this respect did not correspond with the plans. He thought that 1ft. 6in. was an insufficient depth for the foundations, and that the dry summer of this year, during which for a time the lake was empty, had resulted in the fissuring of the clay sufficiently to allow the water, when it returned, to flow beneath the dam. When the washout occurred the escaping water was discharged into a small artificial reservoir immediately below, and the very high pressure caused the concrete dam of this reservoir to burst. Other evidence was to the effect that the concrete of the dam had not been properly mixed and consisted of a rubble of water-worn stones. The coroner, addressing the jury, said he thought it would be desirable if there were some Government Department charged with the duty of seeing that dams were properly constructed. The jury, returning a verdict of accidental death, recommended that dams should be made subject to regular Government inspection, and that before the Dolgarrog Dam was reconstructed the adjoining foundations should be examined by a Government inspector.

Switchgear Developments.

AT a well-attended meeting of the South Wales Institute of Engineers Mr. J. H. Thomas recently delivered a lecture on "Switchgear Developments During the Past Twenty Years." It was in colliery work, Mr. Thomas explained, that the greatest and most radical changes had taken place, and it could be said with little fear of contradiction that in the design of switchgear for mining and general industrial work this country was far ahead of the Continent and the United States. Valuable work had been done in connection with testing switchgear at the Sheffield University. The British Engineering Standards Association had also rendered great assistance, but some of the gear that had been standardised was now almost obsolete. Rules and regulations were sometimes unnecessarily severe and increased the cost of overhead lines and switchgear. For industrial and colliery work, particularly on the surface, a good deal of expensive oil break switchgear was often used when a cheaper form of gear would really suffice. It was the duty of engineers to reduce the cost of installation and to endeavour to influence legislation with a view to making it possible to employ safe and otherwise satisfactory apparatus which could be obtained at a reasonable price.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XLIX.*

PERIOD 1914 TO 1924.

LOCOMOTIVE developments within the final period from the beginning of the war until the present day are well within the memories of those interested, and, moreover, almost every engine of importance has been described and illustrated in THE ENGINEER. Therefore it will be sufficient to tabulate the dimensions of the principal classes, giving in the last column of the tables the necessary reference from which more detailed particulars may be obtained. The following brief comments draw attention to salient features.

Express Passenger Engines.—Table A gives dimensions of express engines of the 4–4–0, 4–6–0 and 4–6–2 types. Of the five 4–4–0 engines only Nos. 1 and 2 were entirely new, the others were "reconstructed." The two Highland engines (2) are the only 4–4–0 locomotives in the country with outside Walschaerts valve motion. The L. and S.W.R. engines (3) were D. Drummond's "463" class of 1911, to which Mr. Urie added Eastleigh superheaters, at the same time removing the fire-box water-tubes. Many of Drummond's engines were similarly altered. The S.E. and C.R. engines, "179" class (4) are superheated engines reconstructed by Mr. R. E. L. Maunsell from a type previously using saturated steam, which worked the Dover express traffic over the "Chatham" section of the railway. As they already weighed the maximum amount permissible, the problem was to reconstruct the engines so that this weight was not materially exceeded. Actually the excess was only ¼ ton. The weights on the driving and trailing wheels were decreased by 0·1 tons and 1·3 tons respectively, and that on the bogie increased by 1·65 tons. The new cylinders, cast with a saddle, remain 19in. by 26in. as before.

The Glasgow and South-Western engine (5) is practically new, and is the only 4–4–0 engine with four high-pressure cylinders.

Of the 4–6–0 engines, Nos. 6, 8 and 10 have two cylinders. Those of the L. and S. W.R. engines (8), 22in. by 28in., are the largest in this country. These and the Highland engines (10) have outside Walschaerts valve gear. The Caledonian engines (11) have three cylinders, of which the two outside drive the second coupled axle, and the single inside cylinder drives the front coupled axle. The Walschaerts valve gear is outside, and the valves of the central cylinder are driven by a floating lever arrangement. Engines Nos. 7, 9, 12 and 13 have four cylinders. The G.C.R. engines (7) have valves driven by inside Stephenson's link motion actuating the bottom lever arm of a rocking shaft, of which the two upper arms, working in synchronism, are attached to the valve spindles of the inside and outside cylinders respectively. Since the cranks on each side are at 180 deg., the valves of the inside cylinders have inside admission and those of the outside cylinders outside admission. The L. and Y.R. engines (12), now the standard 4–6–0 engine of the L.M.S.R., have outside Walschaerts valve gear, the valves of the inside cylinders being driven by rocking levers behind the cylinders. The cylinders, 16½in. by 26in., are the largest now in use for a four-cylinder non-compound engine. The drive is divided between the first two coupled axles. The Irish engine (12) is somewhat similar, but the outside cylinders are placed further back and the inside cylinders further forward, so that the rocking levers are actuated by the front tail rods of the outside valve spindles. The G.W.R. engine (13) of the "Caerphilly Castle" class is generally similar to the earlier "Star" class, but has larger cylinders and a much larger boiler. The tractive effort of the "Castle" class is 31,700 lb., and that of the "Star" class 27,000 lb. The coal consumption of the former is considerably less, to the extent of 3½ lb. per mile. A dynamometer test, the figures of which were given by Mr. Collett at the 1924 World Power Conference, showed 2·1 lb. of coal per I.H.P. hour and 2·83 lb. per D.H.P. hour; mechanical efficiency of the engine 74 per cent., thermal efficiency of boiler, 79·8 per cent.; thermal efficiency $= \frac{\text{work in cylinders}}{\text{heat in coal}} = 8 \cdot 22$ per cent. The coal burnt per ton-mile was 0·101 lb.

Mr. H. N. Gresley's three-cylinder "Pacifics" (14) for the G.N.R. were so fully described and illustrated in THE ENGINEER that only a few salient features need be mentioned here. The boiler is the largest in this country, and has an outside diameter of 5ft. 9in. at the front ring, increasing in the second ring to 6ft. 5in. at the fire-box. The top portion of the fire-box extends towards the barrel, thereby forming a combustion chamber. The combined length of the fire-box and chamber is 7ft. 11¾in., the grate being 5ft. $10^{11}/_{16}$in. long by 6ft. 11¾in. wide. The tubes have a length of 19ft. The inside cylinder is placed further back than the outside cylinders, and is inclined at 1 in 8. All three drive the middle coupled axle. The connecting-rods have bushed ends, and the valve gear is Walschaerts, placed outside, driving the third inside valve through Gresley's floating lever gear. The trailing axle is radial, with outside axle-boxes having inclined planes. These engines have now been adopted as the standard heavy express locomotives of the L. and N.E.R.

The North-Eastern "Pacific" (15) differs from the G.N. in that all three cylinders are in line and drive the first coupled axle. This produces an extremely long engine, with a total wheel base 1ft. 5in. more than that of the G.N. The trailing radial axle has inside bearings in the case of the first two engines, but in the three later engines outside bearings are provided.

Of the express engines, Nos. 1 to 15, in the table, the majority were built at the railway companies' own works. The Highland engines, Nos. 2 and 10, were by R. and W. Hawthorn, Leslie and Co., Ltd., and a number of the Caledonian engines, No. 1, were by the North British Locomotive Company, Ltd., and Armstrong, Whitworth and Co., Ltd. The latter firm also built six of the Great Southern and Western (Ireland) engines (12.) For the L. and N.E.R. the North British Locomotive Company, Ltd., has supplied twenty of Mr. Gresley's 4–6–2 engines, No. 14.

An engine not mentioned in the table is the "Atlantic" express locomotive built by the N.E.R. at Darlington in 1917 with three uniflow cylinders, 16½in. by 26in. and 6ft. 10in. coupled wheels. This engine weighs 79·2 tons, or 2·5 tons more than the standard three-cylinder engines of the 4–4–2 type. It is the only uniflow locomotive still at work

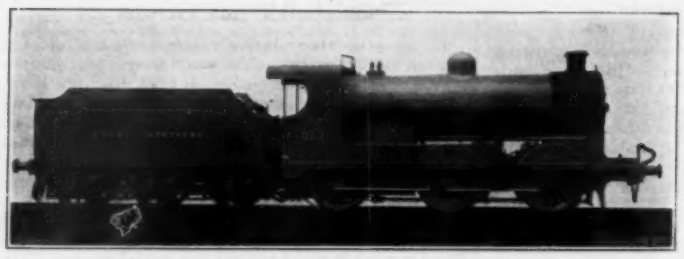


FIG. 310—GREAT NORTHERN (IRELAND) SIX-COUPLED GOODS ENGINE, 1921

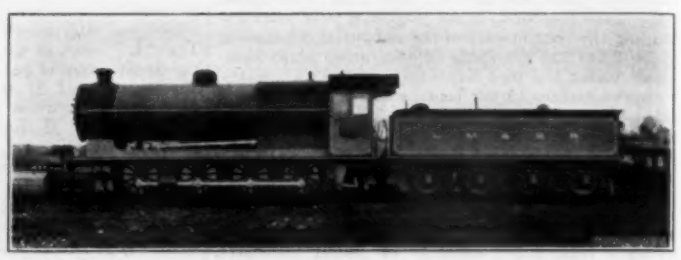


FIG. 311—L.M. AND S. EIGHT-COUPLED GOODS ENGINE, 1923

TABLE A.—*British Express Engines, Period* 1915 *to* 1924.

	Railway.	Designer.	Date.	Type.	Cylinders. i = inside. o = outside.	Driving wheels.	Wheel base. Coupled	Wheel base. Total.	Evaporative heating surface. Tubes.	Evaporative heating surface. Fire-box.	Evaporative heating surface. Total.	Super-heater surface.	Grate area.	Pressure, lb. per sq. in.	Weight in working order. On coupled wheels.	Weight in working order. Total.	Illustrations or drawings in THE ENGINEER.
						dia.			sq. ft.	sq. ft.	sq. ft.	sq. ft.	sq. ft.		tons.	tons.	
1	C.R.	W. Pickersgill	1922	4–4–0	20½" × 26", i	6′ 6″	9′ 9″	24′ 4″	1185	144	1329	300	26·7	180	39·75	61·25	
2	H.R.	C. Cumming	1917	4–4–0	20" × 26", o	6′ 3″	8′ 9″	22′ 11½″	1016	124	1140	180	22·5	160	34·24	54·97	
3	L. and S.W.R.	R. W. Urie	*	4–4–0	20" × 26", i	6′ 7″	10′ 0″	24′ 9″	1139·5	144·5	1284	231	27	180	37·55	59·15	Jan. 11th, 1918
4	S.E. and C.R.	R. E. Maunsell	*	4–4–0	19" × 26", i	6′ 6″	9′ 6″	23′ 6½″	1149·8	127·1	1276·9	228	24	180	33·5	52·5	Jan. 2nd, 1920
5	G. and S.W.R.	R. H. Whitelegg	1922	4–4–0 (4-cyl.)	14" × 24", o 14" × 26", i	6′ 9½″	10′ 0″	24′ 6″	1443·4	148	1591·4	211	27·6	180	38·9	61·45	
6	C.R.	W. Pickersgill	1916	4–6–0	20" × 26", o	6′ 1″	14′ 6″	27′ 6″	1529·5	146·5	1676	258·2	25·5	170	56·5	75·0	Nov. 4th, 1921
7	G.C.R.	J. G. Robinson	1917	4–6–0	16" × 26" (4)	6′ 9″	15′ 6″	28′ 10″	1881	159	2040	343	26	180	57·15	77·9	Jan. 11th, 1918
8	L. and S.W.R.	R. W. Urie	1918	4–6–0	22" × 28", o	6′ 7″	14′ 6″	27′ 6″	1716	162	1878	308	30	180	55·95	77·85	Jan. 11th, 1918
9	L. and Y.R.	G. Hughes	1920	4–6–0	16½" × 26" (4)	6′ 3″	13′ 7″	25′ 7″	1511	175	1686	552	27	180	59·3	79·05	April 15th, 1921
10	H.R.	C. Cumming	1919	4–6–0	21" × 26", o	6′ 0″	14′ 0″	25′ 9″	1328	139	1467	256	25·5	170	45·5	62·25	July 14th, 1922
11	C.R.	W. Pickersgill	1921	4–6–0	18½" × 26" (3)	6′ 1″	15′ 0″	28′ 8″	2200	170	2370	270	28	180	60·0	81·0	Jan. 6th, 1922
12	G.S. and W.R. (Ireland)	E. A. Watson	1921	4–6–0	14" × 26" (4)	6′ 7″	15′ 3″	27′ 1″	1614	158	1772	366	28	175	—	72·5	
13	G.W.R.	C. B. Collett	1923	4–6–0	16" × 26" (4)	6′ 8½″	14′ 9″	27′ 3″	1885·6	163·7	2049·3	262·6	30·3	225	58·85	79·85	Aug. 24th, 1923
14	G.N.R.	H. N. Gresley	1922	4–6–2	20" × 26" (3)	6′ 8″	14′ 6″	35′ 0″	2715	215	2930	525	41·25	180	60·0	92·45	Jan. 5th and 26th, 1923
15	N.E.R.	Sir V. Raven	1922	4–6–2	19" × 26" (3)	6′ 8″	15′ 0″	37′ 2″	2211·2	211	2422·2	695·6	41	200	60·0	97·0	Jan. 5th, 1923

Mixed Traffic, Goods, and Mineral Tender Engines, 1915 *to* 1924.

16	G.E.R.	A. J. Hill	1920	0–6–0	20" × 28", i	4′ 11″	18′ 10″	18′ 10″	1483·1	143·5	1632·6	286·4	26·5	180	—	—	Jan. 7th, 1921
17	G.N.R. (Ireland)	G. T. Glover	1921	0–6–0	19½" × 26", i	5′ 1″	16′ 11″	16′ 11″	1134	132·8	1266·8	333	22·9	175	53·6	53·6	
18	S.E. and C.R.	R. E. Maunsell	1917	2–6–0	19" × 28", o	5′ 6″	15′ 6″	24′ 4″	1393·6	135	1525·6	203	25	200	50·9	59·4	Oct. 5th, 1917
19	G.N.R.	H. N. Gresley	1920	2–6–0	18½" × 26" (3)	5′ 8″	16′ 3″	25′ 2″	1719	182	1911	527	28	180	60	71·7	May 7th, 1920
20	L. and S.W.R.	R. W. Urie	1920	4–6–0	21" × 28", o	5′ 7″	13′ 9″	26′ 7½″	1716	162	1878	308	30	180	55·9	76·95	April 30th, 1920
21	N.E.R.	Sir V. Raven	1920	4–6–0	18½" × 26" (3)	5′ 8″	13′ 6″	27′ 8″	1397·9	166	1563·9	530·1	27	180	58·7	77·7	May 21st, 1920
22	G.C.R.	J. G. Robinson	1921	4–6–0	16" × 26" (4)	5′ 8″	14′ 5″	28′ 3″	1881	163	2044	343	26	180	58·5	79·5	June 24th, 1921
23	L.M. and S.R.	G. Hughes	1923	0–8–0	21½" × 26", i	4′ 6″	16′ 4″	16′ 4″	1656	192	1848	430	25·5	180	66·2	66·2	
24	N.E.R.	Sir V. Raven	1919	0–8–0	18½" × 26" (3)	4′ 7½″	18′ 6″	18′ 6″	1397·9	166	1563·9	530·1	27	180	71·6	71·6	Aug. 20th, 1920
25	G.N.R.	H. N. Gresley	1921	2–8–0	18½" × 26" (3)	4′ 8″	18′ 6″	27′ 2″	1838·5	163·5	2032	430·5	27·5	180	67·35	75·6	†
26	G.C.R.	J. G. Robinson	1918	2–8–0	21" × 26", o	4′ 8″	17′ 1″	25′ 5″	1641	174	1815	308	26	180	67·9	75·2	Jan. 3rd, 1918
27	G.W.R.	G. J. Churchward	1919	2–8–0	19" × 30", o	5′ 8″	20′ 0″	29′ 3″	2062·35	169·75	2232·1	323·9	30·28	225	73·4	82·0	June 4th, 1920
28	M.R.	Sir H. Fowler	1919	0–10–0 (b'nk'g)	16½" × 28" (4)	4′ 7½″	20′ 11″	20′ 11″	1560	158·25	1718·25	445	31·5	180	73·67	73·67	Jan. 7th, 1921

* Reconstructed engines. † No. 25.—An earlier and very similar engine was illustrated and described in THE ENGINEER, July 26th, 1918.

* No. XLVIII. appeared November 27th.

(December, 1924), the other N.E.R. engine having been converted to the ordinary type.

Mixed Traffic, Goods, and Mineral Engines.—The following notes refer to engines Nos. 16 to 28 in the table.

The G.E.R. engine, No. 16, is the largest of the three-cylinder locomotives is due to Mr. H. Holcroft, who patented it before Mr. Gresley's gear (which was designed independently) appeared. The Caledonian engines (11) have a very similar valve gear.

The G.N.R. engines, Nos. 19 and 25, have outside Walschaerts valve gear and Gresley's floating lever

The G.W.R. engine, No. 27, is the only eight-coupled "mixed traffic" engine in the country. The first engine was built in 1919, but a larger boiler has since been provided, to which the dimensions given refer. The drawings in THE ENGINEER showed the original boiler. The drive is on the second coupled

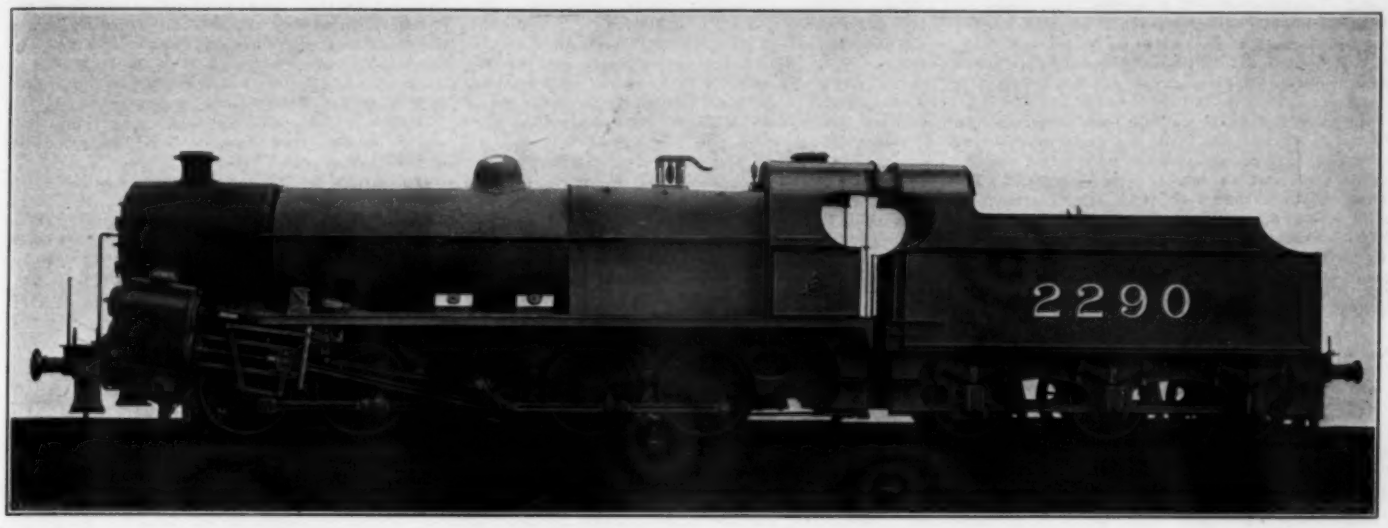


FIG. 312—MIDLAND TEN-COUPLED GOODS ENGINE, 1919

0–6–0 type hitherto constructed. The distance between the driving and trailing wheels is 10ft. The Great Northern (Ireland) engine, No. 17, is shown in Fig. 310, as an excellent example of the latest type of large 0–6–0 goods engine. These Irish engines were

gear for the inside valve. In the 2–6–0 engine, No. 19, all three cylinders drive the middle coupled axle, and in the 2–8–0 engine, No. 25, all drive the second coupled axle.

The N.E.R. engines, Nos. 21 and 24, have inside

axle and the ratio of connecting-rod to crank length is $5\frac{1}{4}$.

The Midland engine, No. 28, Fig. 312, is the only ten-coupled locomotive in the country, the G.E.R. heavy tank engine having disappeared. Although

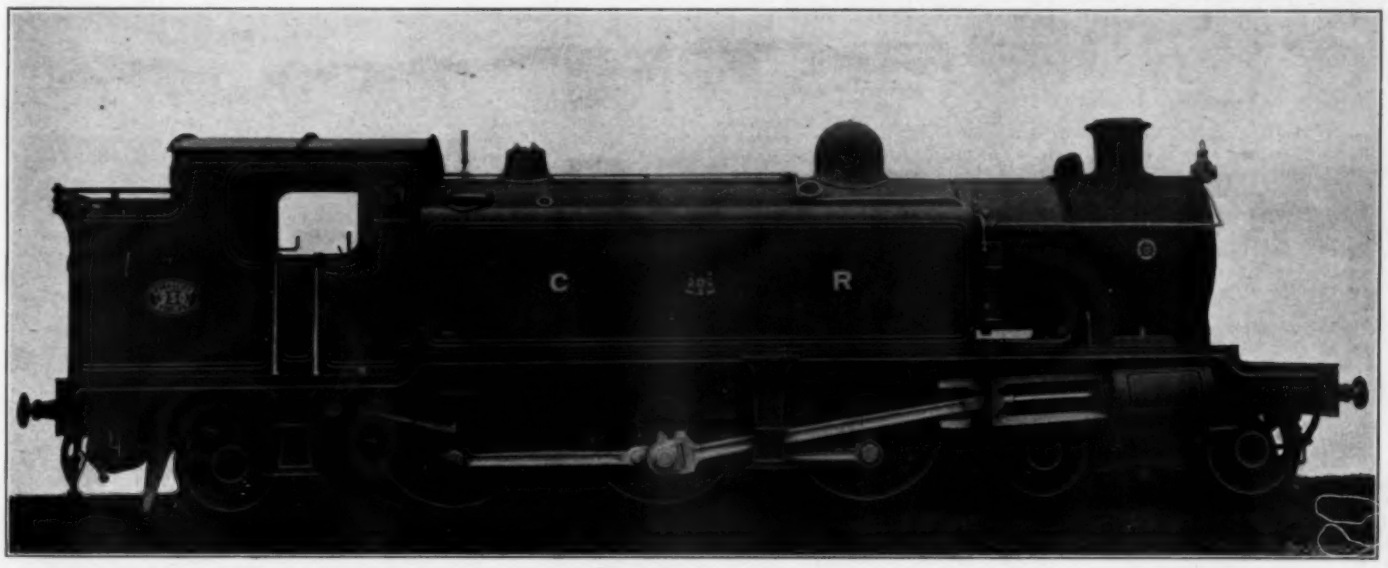


FIG. 313—CALEDONIAN SIX-COUPLED PASSENGER TANK ENGINE, 1917

built by Beyer, Peacock and Co. and have not been illustrated previously.

Of the S.E. and C.R. engines, No. 18, one was built in 1922 with three 16in. by 28in. cylinders. The outside valves above the cylinders are driven directly by Walschaerts valve gear. The inside valve is placed on the left-hand side of the central cylinder and is driven by a system of horizontal levers situated behind the front buffer beam. These levers are actuated on both sides of the engine by long external rods, the back ends of which are attached to short vertical levers, the latter being moved by the valve spindles of the outside cylinders. The rod on the right-hand side moves a long transverse horizontal lever, with a fixed fulcrum, the arms being in the ratio of 7 to 3. The left-hand rod moves a short lever, the other end of which is connected to the front of the valve spindle of the middle cylinder. The arms of this lever are in the ratio of 4 to 3, its floating fulcrum being attached to the near or shorter armed extremity of the long lever. The object of the arrangement is to avoid the transference to the middle valve of the effects of variations due to the expansion of the outside valve spindles, and also to allow the inside piston and all the piston valves to be removed without taking down any of the gear. The outside cylinders are horizontal, but the inside cylinder is inclined at 1 in 8, and the middle crank is at 113 deg. with the right and at 127 deg. with the left-hand crank. An outside view of this three-cylinder engine appeared in THE ENGINEER of February 23rd, 1923.

The above arrangement of lever valve gear for Stephenson's link motion and six excentrics. The drive of all three cylinders is on to the first coupled axle of the 4–6–0 and on the second axle of the 0–8–0 engine.

The L.M. and S.R. (formerly L. and Y.R.) engine,

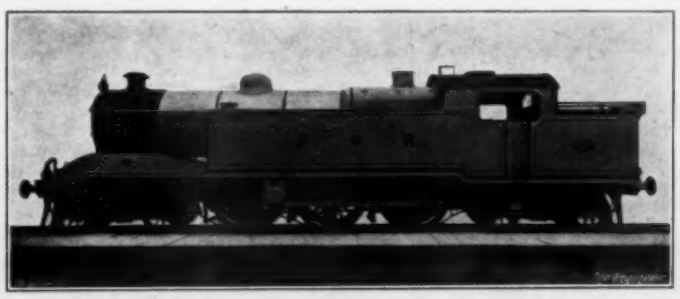


FIG. 314—FURNESS SIX-COUPLED PASSENGER TANK ENGINE, 1920

No. 23, Fig. 311, is an enlargement of Sir John Aspinall's engine of 1900, and has Joy's valve gear. The short wheel base, 16ft. 4in., of this eight-coupled engine may be compared with the 18ft. 10in. base of the six-coupled G.E.R. engine, No. 1.

The G.C.R. 4–6–0 engine, No. 22, is generally similar to the express engine No. 7.

intended for banking trains up the Lickey incline, a tender and not a tank engine was built, since the weight of the latter would have been too great. As built, the axle load does not exceed 15·5 tons, and the weight per foot run of wheel base is 2·29 tons. The tractive force at 80 per cent. of boiler pressure is 18·2 tons. Walschaerts outside valve gear is used, and the two piston valves for the four cylinders have outside admission, the ports of the inside cylinders being crossed. The cylinders are inclined at 1 in 7, the valves being placed above the outside pair. Complete working drawings appeared in *Engineering*, March 5th, 1920.

Tank Engines. — The dimensions of these are given in Table B. Nos. 1 to 10 were built for passenger service, and Nos. 11 to 16 for mixed, goods, and shunting work. The G.E.R. engine, No. 3, for London suburban passenger trains has much smaller coupled wheels than the L. and S.W.R. 4–6–2 engine, No. 13, which is intended for transfer goods and coal traffic between Feltham sidings and the L.M. and S. systems at Brent and Willesden. Nos. 14 and 15 are heavy shunting engines.

The 2–6–4 wheel arrangement, new to British practice, appears in the S.E. and C.R. outside-cylinder passenger engine No. 6, and the G.C.R. inside-cylinder mineral engine No. 12. Of the engines with a bogie at each end, only one, the 4–6–4 engine, No. 8, for the Furness Railway, has the wheel base symmetrically arranged, the distance from the bogie centre to the nearest coupled axle being 10ft. 3in. at each end. In the other 4–6–4 engines, Nos. 9 and 10, the trailing bogie centre is further away from the trailing coupled axle than the leading bogie centre from the front coupled axle. In the Metropolitan 4–4–4 engine the opposite is the case. All the 4–6–4 tank engines have bogies of 7ft. wheel base.

All the main line tank engines, both passenger and goods, are superheated, with the exception of the Furness 4–6–4 tank engines, for which the railway company preferred to use saturated steam. The addition of superheaters to tank engines, such as Nos. 3, 4 and 5, primarily intended for suburban traffic with numerous stops, has now become standard practice. The G.E.R. engine, No. 3, was one of two, the other engine working with saturated steam. Ten subsequent similar engines of 1921 were without superheaters, and had a total heating surface of 1394 square feet, but since the grouping with the L. and N.E.R. the latest engines of the type have again been provided with superheaters. The tube heating surface of these is 858 square feet, fire-box 110·2 square feet, and superheating surface 134·2. Apparently this class is to be one of the standard L. and N.E.R. types, for large numbers of them are now being built at Gorton Works.

For shunting engines superheating is rarely used, and the L. and S.W.R. 4–8–0 engines, No. 14, are exceptional.

The four-cylinder superheated engine for the N.S.R. was the only one of the type, and was the first tank engine to have four cylinders. The outside cranks are placed at 90 deg. with each other, and the inside cranks are also at 90 deg., but the outside and inside cranks on the same side, instead of being opposite each other, are at 135 deg. Each cylinder has its own Walschaerts valve gear. The side tanks have since been removed and the locomotive is now at work as a goods tender engine.

Of the tank engines in the table, Nos. 1, 4, 7 and 9 were built by the North British Locomotive Company, Ltd., No. 2 by Kerr, Stuart and Co., Ltd., and No. 8 by Kitson and Co., Ltd. The Caledonian engine, No. 7, and the Furness engine, No. 8, are shown in Figs. 313 and 314 respectively.

TABLE B.—*British Tank Engines*, 1914 *to* 1924.

	Railway.	Designer.	Date.	Type.	Cylinders. i = inside o = outside	Driving wheels, dia.	Wheel base.		Evaporative heating surface.			Super-heating surface	Grate area.	Boiler pressure.	Weight in working order.		Tank capacity.	Illustration or drawings in THE ENGINEER.
							Coupled	Total.	Tubes.	Fire-box	Total.				On coupled wheels.	Total.		
									sq. ft.	sq. ft.	sq. ft.	sq. ft.	sq. ft.	lb./sq. in.			gallons.	
1	N.B.R.	W. P. Reid ..	1915	4–4–2	19″ × 26″ i	5′ 9″	8′ 3″	28′ 11½″	930	95	1025	220	16·6	165	37·35	73·3	2080	—
2	Metropolitan ..	C. Jones	1920	4–4–4	19″ × 26″ o	5′ 9″	7′ 9″	33′ 6″	1046	132	1178	268	21·4	160	39·0	77·0	2030	Jan. 7th, 1921 Feb. 4th, 1921
3	G.E.R.	A. J. Hill	1914	0–6–2	18″ × 24″ i	4′ 10″	16′ 3″	23′ 0″	1076·3	113	1189·3	102·4	17·7	180	49·22	61·6	1600	Jan. 6th, 1922
4	G.N.R.	H. N. Grosley ..	1920	0–6–2	19″ × 26″ i	5′ 8″	16′ 3″	23′ 9″	880	118	998	207	19	170	55·75	70·25	2000	—
5	N.S.R.	J. H. Adams ..	1916	0–6–4	20″ × 26″ i	5′ 6″	16′ 0″	27′ 9″	887	129	1016	258	21	160	55·5	74·1	2250	March 30th, 1917
6	S.E. & C.R. ..	R. E. L. Maunsell	1917	2–6–4	19″ × 28″ o	6′ 0″	15′ 0″	35′ 10″	1390·6	135	1525·6	203	25	200	52·75	82·6	2000	Oct. 5th, 1917
7	C.R.	W. Pickersgill ..	1917	4–6–2	19½″ × 26″ o	5′ 9″	13′ 3″	33′ 1″	1395	121	1516	220	21·5	170	55·05	91·65	1800	Nov. 11th, 1921
8	Furness	Kitson and Co.	1920	4–6–4	19½″ × 26″ i	5′ 8″	13′ 3″	45′ 9″	1850	153	2003	nil	26	170	54·9	93·25	2200	—
9	G. & S.W.R. ..	R. H. Whitelegg	1922	4–6–4	22″ × 26″ o	6′ 0″	13′ 2″	39′ 0″	1574	156	1730	255	30	180	54·0	99·07	2400	June 16th and Nov. 10th, 1922
10	L.M.S.R.	G. Hughes ..	1924	4–6–4	16½″ × 26″ (4)	6′ 3″	13′ 7″	40′ 4″	1817	180	1997	343	29·6	180	56·5	99·95	2000	Nov. 21st, 1924
11	N.S.R.	J. A. Hookham	1922	0–6–0	14″ × 24″ (4)	4′ 6″	16′ 6″	16′ 6″	750	106·7	856·7	195	17·5	160	56·65	56·65	900	Jan. 5th, 1923
12	G.C.R.	J. G. Robinson	1914	2–6–4	21″ × 26″ i	5′ 1″	17′ 0″	37′ 6″	1386	157	1543	304	26	180	58·75	96·4	3300	Jan. 1st, 1915
13	L. & S.W.R. ..	R. W. Urie ..	1921	4–6–2	21″ × 28″ o	5′ 7″	15′ 0″	36′ 6″	1267	139	1406	231	27	180	59·0	96·4	2000	Jan. 6th, 1922
14	L. & S.W.R. ..	R. W. Urie ..	1921	4–8–0	22″ × 28″ o	5′ 1″	18′ 0″	32′ 0″	1267	139	1406	231	27	180	—	—	2000	Jan. 6th, 1922
15	G.S. & W.R. (Ireland)	E. A. Watson ..	1915	4–8–0	19½″ × 26″ i	4′ 6½″	15′ 3″	29′ 1½″	1426·7	138·5	1565·2	nil	24·8	175	62	80	1500	—
16	L.M. & S.R. ..	H. P. Beames ..	1923	0–8–4	20½″ × 24″ i	4′ 5½″	17′ 3″	29′ 3″	—	—	1687·4	358·6	23·6	185	66·5	88	2030	Nov. 2nd, 1923

The Standardisation of Crane Essentials.

By EDWARD G. FIEGEHEN, M.I. Mech. E.

No. II.*

IN connection with the proposals put forward by the writer in a recent article for the adoption of a standard crane specification, it may now be interesting to discuss some of the points to which attention will have to be given when its provisions are framed. Before doing so, it will be useful to summarise the chief objects which one would hope to attain by the uniformity in practice proposed. They are briefly :—

(1) To secure a uniform basis for tendering.

(2) To increase the efficiency of crane inspection and testing.

(3) To protect the public against dangerous constructions and conditions.

(4) To secure the undoubted economies resulting from greater uniformity in demand and manufacture.

Many other well-known advantages may be expected to follow on standardisation, as experience in many other directions has proved. In the present article it is proposed to discuss briefly a few of the technical aspects of the matter.

Load.—The capacity of a crane is generally measured by the maximum working load that it has been designed to lift. In a machine of this class, the amount of a load cannot be properly considered without reference to inertia effects, which come into play whenever the load is accelerated or retarded, and may indeed in many cases represent a serious increase in the burden actually supported by the lifting hook. Although, in the case of slow-working hand cranes, it might seem reasonable that the allowance for inertia effects should be smaller than that necessary in the case of high-speed machines, it must be remembered that the inertia effects or impact set up, by careless lowering or the accidental slipping of a sling, may be quite as detrimental in the former class as in the latter.

Moreover, inertia effects in the hoisting motion must not be regarded as entirely accidental and of rare occurence ; on the contrary, they are bound to be present to a reasonable degree whenever the crane is being worked at an economical output, even when carefully driven, and they must therefore be considered strictly as part of the regular load in calculations for strength, the factor of safety being properly reserved for taking care of accidental conditions. If the acceleration in a given case is accurately known, the inertia increment can easily be closely calculated, but this is hardly ever possible, and, for the purposes of a general specification, an agreed increment, or "impact coefficient," upon the dead load is more convenient, as in the case of accepted bridge practice. A firm of repute suggests the following :—2½ per cent. inertia increment to be added for hoisting speeds up to 5ft. per minute ; 1 per cent. addition for every additional 5ft. per minute.

According to this rule the increment corresponding to a speed of 60ft. per minute would be 2½ + 11 per cent. = 13½ per cent. The structure and hoisting gear for a 10-ton crane lifting at this speed would thus be designed on the basis of an actual loading of 11.35 tons, using standard working stresses. Flexibility in the load-supporting members certainly tends to reduce the stresses attained under impact, and this fact is recognised in the impact formulæ adopted in bridge practice, but in crane design it will no doubt be better to disregard it.

Inertia.—The effects of inertia, produced by acceleration, must also be considered in connection with the translative movements of the load. In cranes travelling upon rails, the slipping of the driving wheels provides a natural limit to the horizontal force that can be imposed upon the structure, and it is generally considered sufficient to design the parts involved on the basis of the force required to skid the wheels upon dry rails. In such cases it would be quite safe to adopt rather higher working stresses than usual, in view of the automatic limit upon the force that can be imposed. A coefficient of friction of 0·2 between the driving wheels and the rails might be taken as a satisfactory basis. It may be added that this skidding force will also act upon the crane-supporting structure, which must be designed accordingly.

Stability.—Many types of cranes depend for their safe working upon their inherent stability. Unfortunately, this is a matter that is imperfectly understood by many purchasers, and since the margin to be provided for safety must be settled almost entirely upon the results of experience, it becomes one of the most desirable and urgent matters for consideration and standardisation. Stability depends, in most cases, upon deadweight properly distributed, and thus, whilst it is essential to provide enough weight to secure a safe margin, it is most undesirable and wasteful to add an excess of ballast that must at all times be transported by the crane as a non-paying load, and which, furthermore, adds to the price of the machine—a matter of great moment in the face of severe modern competition.

A travelling jib crane running upon a railway must, of necessity, be in stable equilibrium under all conditions. It must, furthermore, possess at all times a sufficient margin of stability, otherwise it will capsize under working conditions. The effective lever arm at which the maximum load acts, tending to overturn the crane forwards, is measured by the nominal radius less the distance from the centre of the crane to the tipping rail, which latter equals half the track gauge ; consequently, the wider the gauge adopted, the greater this deduction becomes and the smaller is the effective overturning moment. Therefore, for a given duty, a broad-gauge crane can be made lighter, and consequently cheaper, than a narrow-gauge crane.

To provide a satisfactory margin against capsizing backwards, the centre of gravity of the unloaded crane must fall a definite distance inside the back tipping rail. This distance can be specified when the conditions are known, and it is useful to note that it is quite independent of the width of the gauge.

Granted that the horizontal position of the centre of gravity of the unloaded crane has been settled in this manner, it is easy to see that the wider the gauge adopted, the greater is the lever arm, measured to the front tipping rail, at which the unloaded weight of the crane acts to secure stablity against the overturning tendency of the load. Consequently, a wide gauge has a double advantage in economising weight and cost.

In the annexed diagram C_U indicates the centre of gravity of the unloaded crane located X_U inside the back rail and at a height H_U above it. It is clear that before the crane can reach a condition of unstable equilibrium, it must careen through an angle α until C_U comes vertically above the back rail. If, then, we can decide upon a safe value for the angle α, the distance X_U can be calculated.

In service, cranes may be required to work on curves and then the super-elevation of the outer rail will incline the machine out of the vertical. A possible sinking of the inner rail or the weakness of a joint may cause a further tip. In the common case of 4ft. 8½in. standard gauge, a super-elevation of 3in., which is not likely to be exceeded, would cause a crane to tip roughly through 3 deg. ; a settlement of the inner rail of 1in. would increase the careen to 4 deg.

It is clear, then, that the angle α must exceed 4 deg. to provide a margin of stability and to provide for other disturbing factors, including wind pressure. The crane should, furthermore, be reasonably secure against capsizing, should derailment occur, possibly at a curve. If derailment took place over the inner rail of the curve, it might cause a further 3 deg. tip.

From the above considerations, it would appear that a value for α of, say, 9 deg. could be considered sufficiently safe for the angle, even under the assumed adverse conditions. It is interesting to note that this angle, again, is independent of the width of gauge.

The consideration of a proper margin to be provided, against tipping forwards under load, presents greater difficulties. Apart from overloading, tipping forward is most likely to be caused by the impulsive action of the load, for instance, the slings may slip, allowing the load to fall a certain distance, being then brought to a sudden stop. Fortunately, the impulse communicated to the crane under such conditions is transient, and does not permanently affect the stability conditions.

The kinetic energy of the falling load is absorbed, first in deflecting the structure, the flexible parts of which thus perform the function of a shock-absorber ; and, secondly, in taking up clearances and raising the tail of the crane. In these operations a time element operates, and in most cases the impulse has expended itself before the crane has tipped sufficiently to be in danger of capsizing. If the impact be very violent

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it may break the sling, which naturally takes the first shock.

To take a numerical example, let us instance a locomotive crane weighing 22 tons unloaded and designed to lift 5 tons at 16ft. radius free upon a 4ft. 8½in. gauge with a 25 per cent. margin of stability. In a severe case the 5 tons load might fall freely through 1ft., owing to the slipping of the sling, and then be suddenly arrested. The momentary drop of the jib head, owing to the deflection of the structure under the impact, might be 6in. We have consequently to absorb kinetic energy equal to 7·5 foot-tons, of which we may assume that 2·5 foot-tons will be taken up in the work of deflection, leaving a balance of 5 foot-tons to be absorbed by raising the centre of gravity of the crane, this rise will be $\frac{5}{22} = 0{\cdot}227$ft.

The height of the centre of gravity of such a crane, H_U, will be about 5ft. above the rail, and its distance behind the tipping rail 4ft., consequently the rise of the crane will correspond to a tip of about 3½ deg.; add to this the 4 deg. margin provided for unfavourable track conditions, and it will be seen that under the conditions assumed, if occurring over the inner rail of a curve, a tip of 7½ deg. might be expected, the combination of conditions assumed is, however, distinctly abnormal.

A commonly accepted and generally satisfactory margin of stability—against forward tipping—is 25 per cent., that is to say, that a dead load of 25 per cent. in excess of the maximum, acting at normal radius and at right angles to the track, will be required to tip the crane.

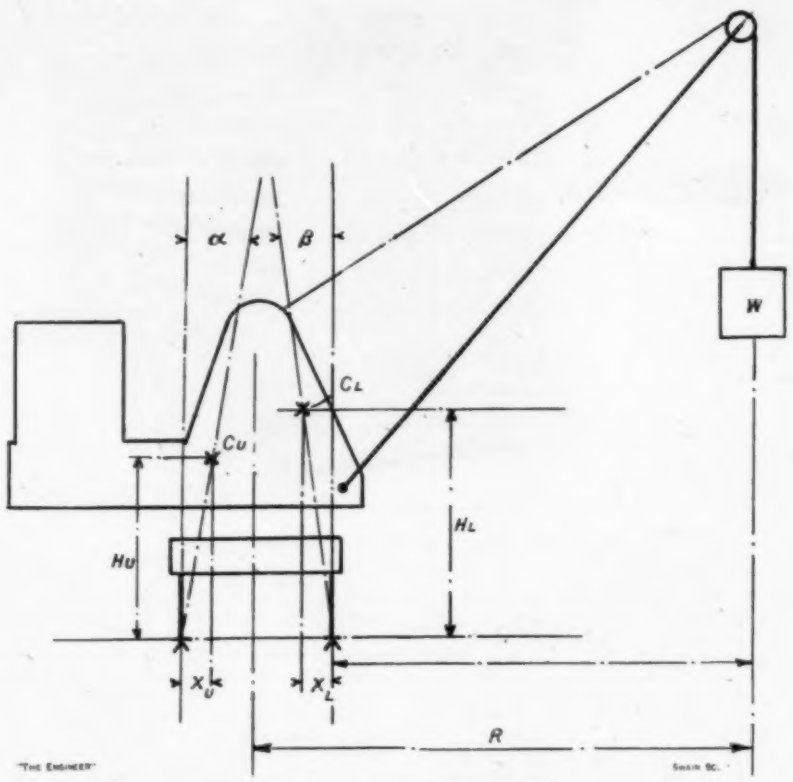


DIAGRAM FOR CRANE CALCULATIONS

In the 5-ton crane described, in order to balance the 1¼-ton overload acting at an effective radius of 16 − 2·4 = 13·6ft., the centre of gravity of the loaded crane—27 tons—must be located $\frac{1{\cdot}25 \times 13{\cdot}6}{27}$ = 0·63ft. behind the tipping rail (X_L).

The most unfavourable condition arises when the load is hoisted up to the jib head, for then the centre of gravity of the loaded crane may be 7ft. high (H_L). In conjunction with the horizontal location of 0·63ft. behind the rail (X_L), this gives a value for the angle β of about 5¼ deg., consequently, on a level track, the careen of 3½ deg. due to impact would fail to overturn the crane. Under the abnormal conditions of sustaining the violent impact of the maximum load over the inside rail of the curve, added to the assumed settlement, it would undoubtedly go over if the sling held. A 25 per cent. margin is, however, found to be quite satisfactory and safe in practice, with intelligent operation, but it is thought that no less should be accepted.

For cranes working rapidly with the maximum load and for grabbing duty and in situations where heavy wind pressures are encountered, the margin is frequently and wisely increased to 33⅓ per cent., or 50 per cent.

On narrow gauges, the stability of a crane can be temporarily increased by the use of outrigger beams blocked up at their ends. They have the effect of temporarily increasing the width of the supporting base, and consequently the lever arm at which the dead weight of the crane acts, whilst, at the same time, they diminish the overturning moment of the load. It is usual to provide 50 per cent. margin of stability under these conditions.

Rail-clips may be provided as a measure of security, but it must be understood that their effectiveness depends entirely upon the resistance of the rails to being lifted, and unless the track is securely bolted down to a substantial and heavy base, such as dock-side stonework or to girder work, no credit can be allowed for additional stability; under favourable conditions, however, they are very useful attachments.

Slewing Speed.—When a load is being slewed by a rotating crane, a horizontal centrifugal force is developed, which, being transferred by the hoisting rope to the jib head, produces an overturning tendency upon the crane proportional to the speed and radius; this tendency has to be resisted by a suitable margin of stability.

The centrifugal force generated is independent of the height of the load above the rails, but its overturning effect upon the crane depends upon the height of the jib head at which point the force is applied.

In what follows it has been assumed, for the sake of simplicity, that the height of the jib head is equal in all cases to the radius; actually this height may be greater than that, at short radii, and smaller at long radii; but, since we propose to ignore the slight balancing effect of the centrifugal force of the tail ballast—about 2 per cent.—acting, of course, to assist the stability of a loaded crane when revolving, the approximation will be sufficient for all practical purposes.

Take the case of the 5-ton crane mentioned above, when slewing 5 tons at 16ft. radius at 3½ revolutions per minute, the jib head being assumed to be 16ft. above the rail.

The overturning moment produced by the rotating load would be $0{\cdot}00034 \times 5 \times 16 \times (3\frac{1}{2})^2 \times 16 = 5{\cdot}33$ foot-tons. The 25 per cent. margin provided for the crane would amount to $5 \times {\cdot}25 \times 13{\cdot}6 = 17$ foot-tons, consequently slewing at this speed can safely be undertaken upon a level track.

It is perhaps unlikely that the full slewing speed would be attempted when the crane was tipped on a curve to the extent of 4 deg. assumed above, at any rate, with the maximum load suspended.

Let us assume then that, out of the 25 per cent. margin provided, we allot 5 per cent. to cover moderately bad track conditions. This leaves 20 per cent., out of which we will reserve 10 per cent., as an available margin of stability, leaving 10 per cent. to balance the overturning tendencies due to slewing.

The effect of the horizontal centrifugal force generated in the load is to make it swing outwards. Under the conditions assumed the horizontal force on the load is 0·334 ton, and the tangent of the angle of the rope to the vertical, for equilibrium, will therefore be $\frac{0{\cdot}334}{5} = 0{\cdot}066$, and the outward inclination of the hoisting rope will be 3·8 deg. at all radii, at the safe speeds tabulated below, which are calculated upon a uniform basis. The outward swing of the load thus increases the nominal radius R by 7½ per cent., and in what follows this corrected value will be used in calculating the centrifugal force of the load.

Let W = load in tons,
R = nominal radius in feet,
r = effective tipping radius (R − ½ gauge),
H = height of jib head (assumed = R),
N = revolutions per minute to absorb 10 per cent. stability as assumed.

Now, 10 per cent. margin = $\frac{W\ r}{10}$

Allowable centrifugal force = $\frac{W\ r}{10\ H}$

By assumption = $\frac{W\ r}{10\ R}$

Centrifugal force = $0{\cdot}00034\ WN^2 \times 1{\cdot}075\ R = \frac{W\ r}{10\ R}$

$$N^2 = \frac{W\ r}{10\ R \times 0{\cdot}00034\ W \times 1{\cdot}075\ R}$$

$$= \frac{r}{0{\cdot}0036\ R^2}$$

$$N = \sqrt{\frac{273\ r}{R^2}}$$

$$= \frac{16{\cdot}5\sqrt{r}}{R}$$

This formula gives the following results:—

4ft. 8½in. Gauge.

R	=	16	..	30	..	40	.. 60 feet
r	=	13·6	..	27·6	..	37·6	.. 57·6 feet
$\sqrt{r}$	=	3·69	..	5·25	..	6·13	.. 7·59
N	=	3·8	..	2·88	..	2·53	.. 2·08 r.p.m.

7ft. Gauge.

R	=	16	..	30	..	40	.. 60 feet
r	=	12·5	..	26·5	..	36·5	.. 56·5 feet
$\sqrt{r}$	=	3·54	..	5·14	..	6·02	.. 7·52
N	=	3·65	..	2·84	..	2·48	.. 2·07 r.p.m.

It must be clearly understood that these limiting speeds apply only to maximum loads, and to the margin of stability—10 per cent.—assumed to be available, they correspond fairly with modern practice. The corresponding lineal speeds of slewing range from about 380ft. per minute at 16ft. radius to 780ft. per minute at 60ft. radius.

Wind Pressure.—It is suggested that cranes should be designed to continue in operation under wind pressures up to 5 lb. per square foot, whilst their stability and strength should be capable of withstanding 30 lb. per square foot. Under the latter extreme conditions stresses might be allowed to reach, say, 60 per cent. of the elastic strength of the materials.

Rail Adhesion.—To be taken at 450 lb. per ton in strength calculations, and at 300 lb. per ton for shunting duties ("adhesion").

Jibs.—To be designed to resist a side loading applied to the top of the jib, caused by inertia during slewing, equal to 10 per cent. of the suspended load, in addition to normal compression, deadweight bending, &c.

Hooks.—Tested with twice maximum load without showing permanent set.

Ropes.—Suggested factor of safety:—

$$\frac{\text{Guaranteed breaking load}}{\text{Maximum rope load}} = 7$$

Minimum diameter of barrels — 6 circumferences
Minimum diameter of pulleys — 7 circumferences
Barrels and pulleys to be machine-grooved.
Reverse bends to be avoided.
Mild quality rope (90 to 100 tons B.S.) recommended.

Brakes.—To hold safely 50 per cent. overload torque. Stresses under maximum load not to exceed half standard working stresses. Reasonable wear must not reduce grip.

Power-traveller Girders.—It is suggested that these girders should be designed to resist, in addition to normal vertical bending, a horizontal bending moment equal to 10 per cent. of the vertical bending moment, as a provision against inertia bending effects in the horizontal plane. This force will be applied through the rail, generally fixed to the top or compression flange, where its effect requires serious consideration. As an example, let us instance a 10-ton overhead electric crane, span 40ft., weight unloaded 10 tons, longitudinal travelling speed 300ft. per minute. As above, we will assume the coefficient of friction between the driven track wheels and the rail to be 0·2. Suppose that, when at full speed, a braking action sufficient to skid the wheels is applied. With the 10-ton load at the centre of the span, the load on each of the two driven wheels will be $\frac{20}{4} = 5$ tons, and the corresponding horizontal retarding force at each rail $5 \times 0{\cdot}2 = 1$ ton. The resulting horizontal bending moment, shared by two girders, will be about 20 foot-tons.

Now, the vertical bending moment, also shared by two girders, will be about 140 foot-tons, one-tenth of which is 14 foot-tons. Owing to the deflection of the girder flange horizontally under the impact, the maximum stress produced will be greater than the mean stress equivalent to the skidding force, consequently, the 10 per cent. assumption would appear to be reasonable.

Hand Cranes.—For the sake of uniformity, it is suggested that the design of hand crane gearing should be based upon the assumption that each man working

upon a winch handle will exert a mean force of 30 lb. at a mean speed of 30 revolutions per minute, when lifting the maximum load. Not more than two men to be assumed to work at any handle.

Similarly, when pulling upon a vertical hand chain, one man may be assumed to exert 75 lb. at a mean speed of 120ft. per minute—two men, working upon the same chain, to produce an effort of 120 lb. at 120ft. per minute under maximum load. Authorities differ greatly in this matter, and many suggest lower figures, but it is found in practice that the provision of increased mechanical advantage tends to reduce the speed of handling light loads, which generally constitute the bulk of the lifts, and also permits on occasion serious overloading of the crane, owing to the deceptive ease of operation.

Operating Speeds.—There is scope for a limited standardisation of power-crane operating speeds, and it is to be feared that there is much misconception on this matter. It is useful to remember that the adoption of suitable high speeds does not increase the total energy consumed during a given cycle of operations, for, whilst the increased accelerations involved may consume more power, the higher electrical efficiency of the larger motors provided, added to the increased mechanical efficiency of lower gear ratios, may easily restore the balance. Consequently, it is found that the operating cost per cycle of the high-speed crane is no more than that of the low-speed crane. The extra capital cost of the larger motors and control equipment may be somewhat offset by a saving in the cost of gearing.

The function of a power crane is to save time, and when the crane can be continuously employed, as in dockside work, the value of the time saved may alone render the high-speed design a good paying proposition. For the best results, operating speeds must bear a proper relation to the rate at which the crane can be loaded and discharged, the upper limit, of course, being settled by considerations of safety. The selection and classification of acceptable speed ranges will not be easy.

There will, of course, still arise special applications calling for individual consideration, but in the majority of cases the matter does not receive the consideration it deserves. As explained above, natural limits are imposed upon such motions as slewing. It is suggested that a high and a low standard speed for each movement appropriate to the load and conditions would after a time prove to be acceptable and sufficient, and its adoption would tend towards uniform construction and would produce a common basis for tendering.

As a parallel case, we may instance the acceptable and uniform rating already adopted for crane motors, half-hour rating and one-hour rating. It is found by experience that these two ratings fulfil practically all ordinary requirements and are rarely departed from. The motor manufacturers are in consequence greatly assisted in standardisation of output and in holding saleable stocks, consequently quick deliveries and satisfactory spare-part service is assured. The same tendency is being shown in the present standardisation of a limited number of voltages and periodicities.

Standard Sizes.—The increments in load capacity between stock sizes of cranes has already been fixed to a certain extent by common consent. A typical range of sizes for travelling cranes would appear to be —1, 1½, 2, 3, 5, 7, 10, 15, 20, 25, 30, 50, 75, 100 tons.

If an inquiry is received for a crane of, say, 4, 8 or 12 tons capacity, we shall probably find that some makers would offer in each case their next higher standard size, whilst others might make minor alterations to their next smaller size, and by so doing would secure an unfair advantage in competition.

The actual percentage difference between the production cost of a 5-ton and a 7-ton crane is not usually great, the difference being mainly composed of material cost. It would certainly not be worth splitting to produce a 6-ton size. In other branches of industry, little difficulty has been experienced in educating the customer to make his selection from a limited number of standard sizes, and it is found that all parties benefit materially thereby, especially in the matters of delivery and spare-part service. We can hardly imagine an inquirer calling seriously for 2⅞in. steam pipe! Can he not therefore be persuaded not to call for a 13¼-ton crane, just because that happens to be the exact weight of his heaviest lift?

In the case of locomotive jib cranes of moderate capacity a standard radius of 16ft. has been pretty generally adopted as a basis and is satisfactory. So many factors are involved in the application of this type of crane that only a limited standardisation on a basis of 16ft. radius and 4ft. 8½in. gauge would appear possible or desirable. The manufacturer of this type has frequently placed before him the choice between offering a standard pattern somewhat in excess of actual requirements or of suitably stiffening up and ballasting the next smaller size.

It is hoped that the foregoing remarks may serve to indicate to the reader some of the directions in which it is believed benefit would be derived from wise and moderate standardisation. To standardise too rigidly would be most undesirable, but it is thought that some effort should be made to lift the industry out of the haphazard conditions at present imposed upon it, and to place it in line with others which have already benefited by careful co-ordination. Only by so doing can the cost of production be materially decreased and prompt delivery and spare part service ensured. British cranes are still probably the best in the world, but they are costly; if we are to regain lost markets, we must follow the path that has led other industries to improved conditions.

The Shipping, Engineering and Machinery Exhibition.

No. III.*

We continue below our account of the exhibits at the Shipping, Engineering and Machinery Exhibition at Olympia.

E. Green and Son, Ltd.

On the stand of E. Green and Son, Wakefield, there was the familiar model of an economiser fitted to a water-tube boiler, which is so well known that it need not be described to readers of The Engineer, and several models of detail parts. These models included a short section of the "Tri-Tube" economiser

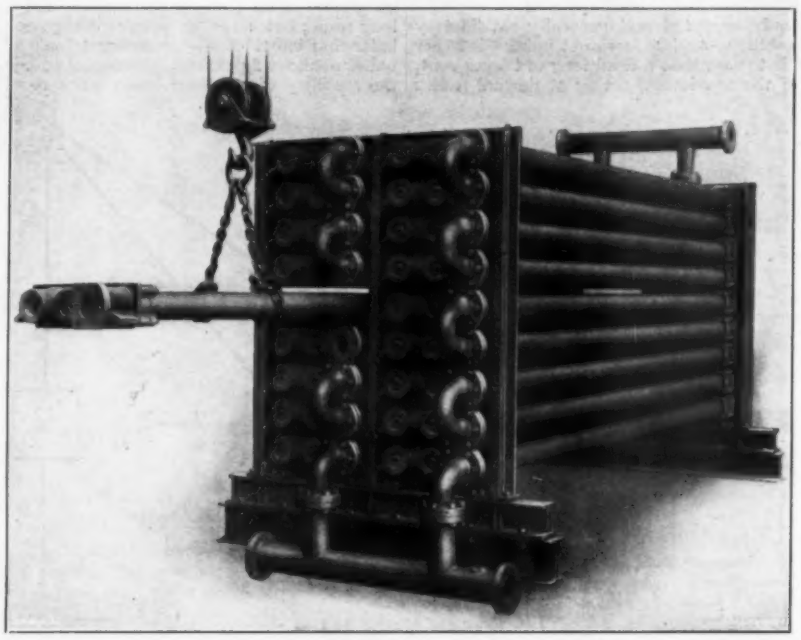


FIG. 41—TRI-TUBE HORIZONTAL ECONOMISER—GREEN

—illustrated in Fig. 41—which is the latest form developed by the makers for installation in connection with modern high-pressure boilers.

For reasons of economy in floor space it is common nowadays to mount the economiser over the top of the boiler, but it is not always possible to find accommodation for the high vertical type of apparatus. In these cases the "Tri-Tube" economiser is very useful, as it can be made up in various heights and, in any case, it requires less headroom than is necessary for the vertical form.

The economiser, it will be seen, is made up of groups of tubes arranged in sets of three. The tubes are of cast iron—like the original apparatus—and are fixed in short horizontal headers. The centre one of the three tubes is fixed with a plain push joint, the same as that used in the vertical economisers, but the two outside tubes have the added assurance of a positive mechanical hold, on account of the high pressures at which these economisers are intended to work—some of them working under pressures of 400 lb. per square inch. The joint is formed by shouldering the end of the tube where it enters the header. A split ring bears against the shoulder and a ring plate behind, in conjunction with four studs, is used to pull the tube home in the header. These joints, we are told, are capable of withstanding a pull of 20 tons, irrespective of the friction of the push joint, and there is, consequently, a big margin of safety, as, even at the high pressure just mentioned, the force tending to pull the header off the three tubes is little more than 6 tons, and the two ring stay joints alone are good for 40 tons.

In these horizontal economisers the cold feed water is introduced into the lower rows of tubes and the circulation is arranged to go through them, either in series—as is shown in Fig. 41—or through several groups at a time. Individual sections can be easily removed in the manner shown.

Redrup Motors Ltd.

An interesting example of a two-stroke internal combustion engine of original design is shown by Redrup Motors, Ltd., 115, Shaftesbury-avenue, London, W. The makers claim that by this method of construction perfect dynamic balance is achieved, while the ratio of power developed to the weight of the engine is high. A sectional view of a six-cylinder engine is shown in Fig. R4. The method by which the fore-and-aft motions of the pistons is converted to a rotary movement of the shaft is the chief feature of novelty of this engine, which, we understand, has been tested on a double-ended ship's boat, 25ft. long by 7ft. 6in. beam. The six cylinders A, with a bore and stroke of 2½in. and 4in., are disposed horizontally round a central shaft B and, using petrol as fuel, develops 5 brake horse-power at 300 revolutions per minute, 11·78 brake horse-power at 700 revolutions per minute, and 16·72 brake horse-power at 1000 revolutions per minute. The overall diameter of the engine casing is 13in. and the length 17in. The crank shaft is carried in bearings at each end of the casing and has a crank pin 7½in. long, the axis of which is inclined to the axis of the shaft at an angle of about 15 deg. Power from the cylinders is transmitted to the crank shaft by means of a star-shaped member C which is free to oscillate round a boss D, the arms being connected to the pistons by means of gudgeon pins. While free to move circumferentially in relation to the boss, the arms are held rigidly in the longitudinal direction by ring nuts E, which also serve to hold the two halves of the boss together. The cylinders are water jacketed for the full extent of the working stroke, and the lubricating oil is forced into the crank case at one of the end journals. The oil passing through the hollow crank shaft goes to the extreme end bearing and also to the arms on the coupling members by way of hinge pins to the gudgeon pins in the pistons. It will be seen that the latter are of hollow cylindrical form.

The main casing is in halves to facilitate assemblage and the cylinders are provided at one end with a removable water-jacketed combustion head F and

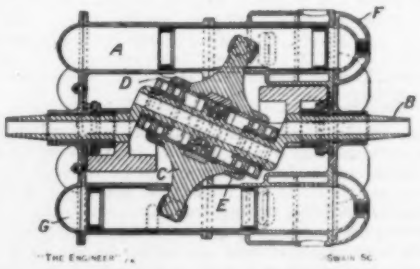


FIG. 42—TWO-STROKE ENGINE—REDRUP

with a removable pump head G at the other end. Each of the pump heads is provided with an extension to communicate with a transfer pipe placed between the cylinders and leading to the inlet port of its appropriate cylinder. The three port system is employed, one for admitting the charge from the carburetter to the pump cylinder and the other two for the inlet and exhaust ports. A pipe leading from each of the pump inlet ports runs direct to the top or bottom of the engine casing, with a centrally arranged intake. The exhaust from each cylinder passes through the water space and issues at the combustion end of the engine between the cylinder heads, where it can be connected to a collector ring.

* No. II. appeared November 27th.

LACY-HULBERT AND CO., LTD.

The air compressors made by Lacy-Hulbert and Co., Ltd., of Boreas Works, Beddington, Croydon, have always been recognised as being of the high-speed type, but recent developments in their design have enabled these machines to be run at even higher speeds than before. In Fig. 43 we illustrate one of these compressors capable of delivering 80 cubic feet of free air per minute, at a pressure of 120 lb. per square inch, when running at 950 revolutions per minute. It is driven by a 17 horse-power petrol engine, to which it is directly coupled.

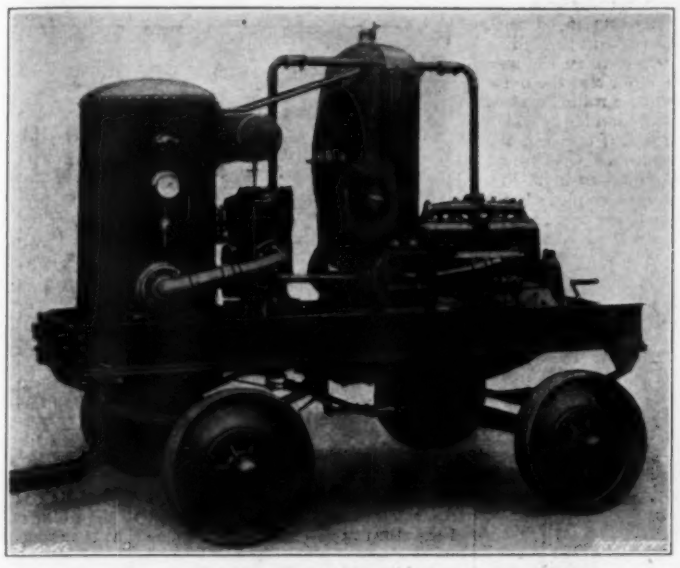


FIG. 43—PORTABLE AIR COMPRESSOR—LACY-HULBERT

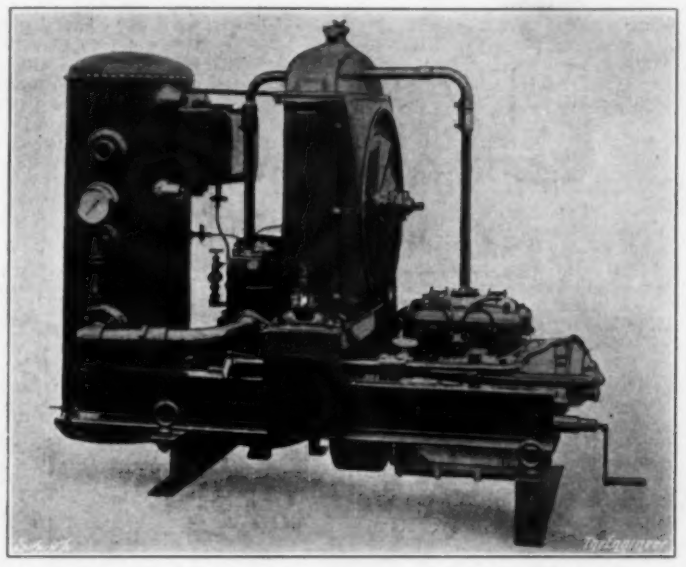


FIG. 44—SEMI-PORTABLE AIR COMPRESSOR—LACY-HULBERT

On reference to the illustration, it will be noticed that the radiator is mounted in the middle of the frame, between the engine and the compressor. This arrangement has the advantage of not only simplifying the pipe connections to the two machines, but it also greatly reduces vibration. We understand that one of these sets has been put together with the radiator at the end, and that it vibrated considerably. With the radiator as shown, however, vibration is scarcely perceptible. The explanation is, no doubt, to be found in the synchronism of the pulsations with the natural period of vibration of the machine.

The outstanding feature of these compressors is, however, their high volumetric efficiency, when their high speed is taken into consideration. This high efficiency, which the makers claim to be as much as 120 per cent., is attained by using the crank case as a sort of supercharger. The case is made as compact as possible—to the extent of using wood blocks to fill up unnecessary spaces—and in this way the air it contains is compressed to a pressure of 7 lb. per square inch at each stroke of the piston. There is a transfer port, just like that of a two-stroke engine, which takes the air to the cylinder, near the end of the stroke. The cylinder is fitted with inlet valves in the usual manner, but it is, of course, impossible through them to fill the cylinder with air at atmospheric pressure. At the end of the stroke, however, the piston over-runs the transfer port and the charge of air from the crank case raises the pressure in the cylinder to something more than that of the atmosphere before the compressing stroke is started.

FIG. 45—TIRE INFLATOR—LACY-HULBERT

The machine illustrated by Fig. 44 is, it will be seen, of the semi-portable type, and is the same in general principle as that just described. It is capable of delivering 30 cubic feet of free air per minute at a pressure of 120 lb. per square inch, and is driven at a speed of 1250 revolutions per minute by a 7 horse-power engine. The little machine shown in Fig. 45 is intended for inflating pneumatic tires, and is noteworthy through being weatherproof; in fact, were it not necessary to have an inlet and outlet for the air, it might be called water-tight. The motor is powerful enough to start the compressor against full load, so that it is possible, in pumping up a tire, to stop the pump to test the hardness of the tire, and then start it again readily if a little more air is needed. The machine weighs only 65 lb.

HADFIELDS, LTD.

The stand of Hadfields, Ltd., East Hecla Works, Sheffield, is devoted to a demonstration of the characteristics of two new types of steel manufactured by that company.

In some respects these steels are similar in their natures, but each has been produced for a specific purpose. One is intended to resist corrosion in general and the other to resist the wasting effects of high temperature. Of these two materials, the latter is perhaps the more interesting, as we are now becoming more or less used to the idea that steel can be made resistant to corrosive influence and still retain its common characteristics.

The heat-resisting steel is known as Era H.R. steel, and one of the most striking demonstrations of its endurance on the stand is a specimen which has been in an electrically heated muffle ever since the Exhibition opened. The muffle is open to the atmosphere, so that there is an oxidising tendency within, and the sample of special steel is lying alongside a piece of ordinary mild steel. At the time of our inspection the muffle had been running at a bright red heat for a full week, and the piece of mild steel was barely recognisable as such. On the other hand, the Era steel had obviously retained its original form, and was little the worse for its prolonged heating. Some more precise tests which have been carried out in the Hadfield laboratories show that while the loss by scaling of a piece of ordinary mild steel heated to 1000 deg. Cent. for three hours amounts to over 28 per cent., the corresponding loss with Era steel is only 0·07 per cent. The metal is, nevertheless, of a "workable" nature, and can be cast, forged or machined. In forging a certain degree of special skill is necessary, but, in machining, ordinary practice can be followed. When, however, grinding is resorted to some special care is necessary, as no sparks are produced in the process—a peculiarity naturally following the non-oxidising character of the metal—and it is not easy to estimate the depth of cut being taken until the job is gauged. Judged by ordinary tensile tests, this steel has a maximum stress of over 58 tons per square inch at normal temperatures, and it is only reduced to 19 tons at 900 deg. Cent. As at high temperatures all materials are, to a greater or less extent, viscous, the merits of a material for use at high temperatures are best indicated by the maximum stress which it can sustain without a substantial creep. At somewhat lower stresses a creep can sometimes be observed, which, however, is not sustained, and after a few hours the material becomes rigid again. The creep stress for the steel under review has been determined at 11 tons per square inch at 700 deg. Cent., at which temperature ordinary 0.3 per cent. carbon steel has a creep stress of less than 1 ton per square inch. The value of such a material needs no emphasis to any engineer.

The corrosion resisting steel, known as Hecla A.T.V., is noteworthy on account of the fact that it does not rely on a highly polished surface for its resistant qualities, and is apparently equally immune whether it is roughly machined or carefully finished. This characteristic is attributed to the fact that the steel is a solid homogeneous alloy which does not depend on heat treatment for its corrosion-resisting qualities. In this connection we have inspected some samples of plain rolled sheets which had been bent backwards and forwards several times, so as to stress the surface layers, that had been lying about for some time, and they showed no signs of corrosion. On the stand at Olympia there is also an apparatus, much in the form of a windmill, which continually dips several specimens of steel into a bath of brine, and then exposes them to the air. The sample of Hecla steel plainly withstands this treatment better than any of the others. This steel has a yield point of 30 tons per square inch at normal temperature, a maximum stress of 50 tons, and an elongation of 20 per cent. The Brinell hardness is about 200, and the metal is easily machined.

NORMAN ENGINEERING COMPANY.

Various kinds of pumping plant are shown by the Norman Engineering Company, of 23, Budge-row, Cannon-street, one of the most interesting being the Jennings-Hytor plant for dealing with sewage,

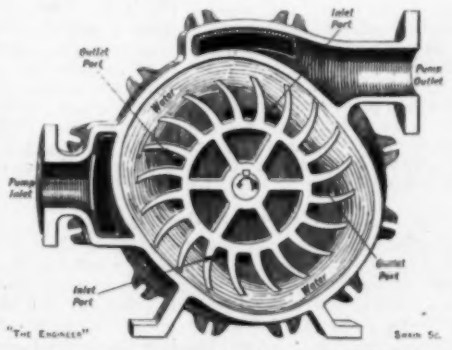


FIG. 46—THE JENNINGS-HYTOR PUMP—NORMAN

waste products, or liquids having heavy solids in suspension. It is of the pneumatic type, the ejector and the compressor possessing some original features, as will be noted from the illustrations Figs. 46 and 47. Taking the compressor first, it will be seen from the sectional view, Fig. 46, that it comprises a circular rotor with blades forming a series of chambers. The rotor revolves freely in a counter-clockwise direction and without contact with the casing, which is elliptical and is filled with clear water from some available source. When the rotor is set in motion the blades carry the water round with them, but the casing being elliptical, while the rotor is circular, it is obvious that centrifugal force will cause the water to leave the chambers formed by the blades of the rotor at the wide parts in the casing and the water will be again forced back into these chambers as the blades reach the narrow parts of the casing. Inlet ports are provided through which air enters as the water leaves the rotor blades. The air is carried round, and at the narrow points where water is again forced in towards the rotor this air is compressed and passes through

outlet ports in the casing to the ejector chamber itself. The device is very simple and there is little or nothing to get out of order. At Olympia the compressor is shown operated by an electric motor which can be automatically started and stopped in accordance with the requirements of the sewage plant.

With regard to the ejector, the sewage which has to be dealt with flows from its source into the pot as shown in Fig. 47 by way of the non-return valve, and as the sewage rises in the chamber the ball float rises with it. When the chamber is full the ball float

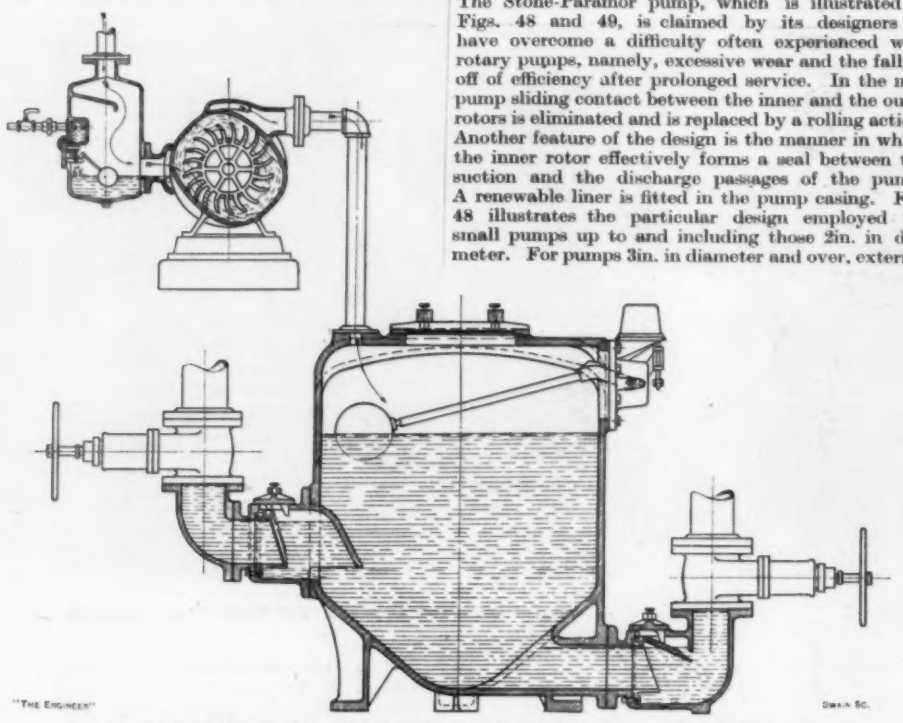


FIG. 47—ARRANGEMENT OF JENNINGS-HYTOR SEWAGE LIFTING PLANT—NORMAN

actuates a float switch which starts the compressor motor and the air under pressure expels the sewage through the outlet check valve shown at the bottom right-hand side. When the pot is empty the float, having reached its lower limit, opens the float switch and stops the compressor, and so the action is repeated as required. It will be seen that when the compressor is delivering air the inlet and outlet ports are effectively sealed from each other by the revolving ring of water, and that when the compressor is not operating the water falls to the bottom of the casing, permitting a free passage of air back through the compressor, making a vent to the atmosphere whereby the air from the receiver can escape as the fresh charge of sewage comes in. This arrangement eliminates air valve mechanism. One of the advantages claimed for this system is that the pressure produced by the compressor is only that which is required to pump the sewage, and there is no air stored under pressure which is liable to leak. The discharge from the ejector takes place at the lowest point, and there is therefore no accumulation of solids in the bottom. A large opening at the top gives easy access, and the check valves can be got at without breaking any pipe joints. The plant shown in motion is capable of dealing with 50 gallons of liquid per minute and is arranged so as to be suitable for lifting ships' sewage.

MICHELL BEARINGS.

Perhaps the most interesting feature of the stand of Michell Bearings, Ltd., Newcastle-on-Tyne, is a working model showing the formation of an oil film in ordinary and Michell journal bearings. In the ordinary journal bearing the pressure oil film is formed by reason of the radius of the brass being greater than that of the shaft, and the centre of the shaft being thereby able to take up a position excentric to that of the brass. The model aims at demonstrating that a part only of the surface in an ordinary journal bearing is capable of generating oil pressure, whereas with the Michell journal bearing the surface is divided into two or more pads of the same radius as the shaft, each of which is pivoted at a point behind its centre in the direction of motion. By this form of construction the bearing has converging surfaces only, the non-load-supporting or suction section being eliminated. The advantages claimed for the Michell system are: (1) The reduction of friction by cutting out that part of the surface which in an ordinary journal generates friction without supporting load; (2) that it generates pressure oil films over a much wider arc of the bearing surface; (3) that it enables bearings to be designed according to Reynold's theory of lubrication; and (4) that it obtains the automatic generation of pressure oil films and maintains them by the mechanical construction of the bearing instead of by an indefinite radius difference. In the working model shown the formation of the pressure oil film without any corresponding suction is seen in the case of a single pivoted pad. Two or more such pads are usually fitted in a Michell journal bearing. The other exhibits of this firm are familiar to readers of THE ENGINEER.

J. STONE AND CO., LTD.

Among the various land and marine specialities shown on the stand of J. Stone and Co., Ltd., of Deptford, we noted a new type of rotary pump which has been introduced for dealing with industrial liquids, such as water, oils, molasses, liquid chocolate, &c. The Stone-Paramor pump, which is illustrated in Figs. 48 and 49, is claimed by its designers to have overcome a difficulty often experienced with rotary pumps, namely, excessive wear and the falling off of efficiency after prolonged service. In the new pump sliding contact between the inner and the outer rotors is eliminated and is replaced by a rolling action. Another feature of the design is the manner in which the inner rotor effectively forms a seal between the suction and the discharge passages of the pump. A renewable liner is fitted in the pump casing. Fig. 48 illustrates the particular design employed for small pumps up to and including those 2in. in diameter. For pumps 3in. in diameter and over, external bearings of the ball or roller type are introduced, and they are carried in housings attached to the pump cheeks as shown in Fig. 49.

Another exhibit which we have singled out for illustration—see Fig. 50—is the Stone-Blake rope guard, which is a simple device for preventing the fouling of a ship's propeller by wire ropes, weeds, or other obstructions. As will be understood from the illustration reproduced, the apparatus consists essentially of a number of cast steel segments, which are so spaced around the stern tube boss that easy access for driving in wedges, taking measurements or doing other operations incidental to propeller repairs is given. Each of the attached segments is provided with a series of ribs on which are formed internal and external serrated cutting edges. Some of the ribs are carried right aft so as to be almost in direct contact with the actual face of the propeller boss. By this provision it is rendered almost impossible for a wire rope to slip in between the guard and the propeller boss.

Should a wire rope be so thrown that it is drawn across or flung in contact with the serrated edges it is quickly cut and severed before any winding up, which might easily damage the propeller, can take place.

In the event of the rope not being thrown with sufficient force to sever it, it is claimed that the guard holds it in a convenient position, from which it may

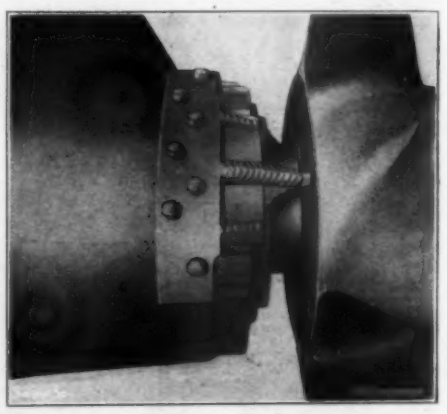


FIG. 50—THE STONE-BLAKE ROPE GUARD

be cut and removed by a diver. It should be noted that the guard is permanently fixed to the outer end of the stern tube boss by welding, so that it cannot be lost at sea owing to vibration loosening, and removing the holding down bolts. The device we have described has, we are informed, been fitted and used on the White Star liners Majestic and Olympic with considerable success.

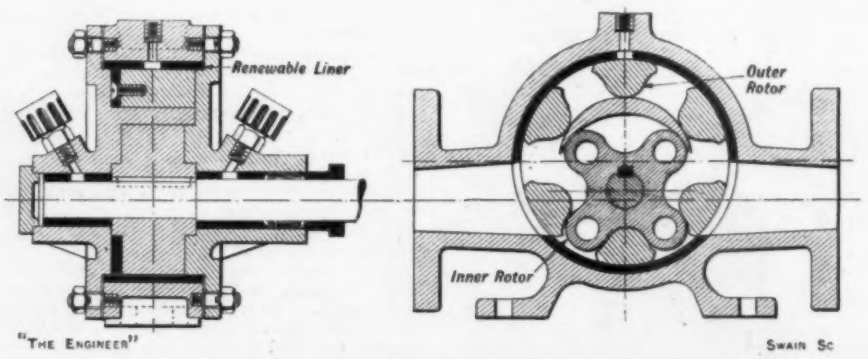


FIG. 48—SECTIONS THROUGH STONE-PARAMOR ROTARY PUMP

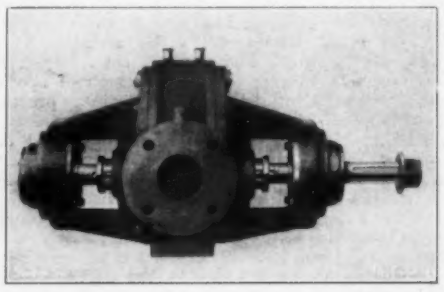


FIG. 49—THE STONE-PARAMOR ROTARY PUMP.

BABCOCK AND WILCOX, LTD.

The extensive range of models and full-sized exhibits which are displayed on the stand of Babcock and Wilcox, Ltd., of Babcock House, Farringdon-street, London, and Renfrew, Scotland, cover a wide field relating to boilers and steam fittings. Conveying machinery and lifting gears, in which the firm also specialises, are well represented, in addition to which there is a new development in the shape of a 15 brake horse-power Babcock crude oil engine made to the designs of Clayton and Shuttleworth, Limited, and built at Babcock's Lincoln works. Among the boiler models an interesting series shown under working conditions serves to illustrate the Fuller-Kinyon system of burning pulverised coal. The Fuller-Kinyon pump designed to convey pulverised materials over long distances is shown in operation. By the addition of a small amount of compressed air the finely pulverised material is converted into a semi-fluid state, in which condition it can be readily handled by the pump. The actual construction of a combustion chamber with pulverised fuel burners is shown in model form. Another model shows the Fuller pulverising mill, which is of the ball type. Actual examples of Fuller-Kinyon practice include a full-sized branch pipe and valve are displayed as well as a burner of the vertical type.

A particularly interesting marine exhibit is a large ship's winch of the totally enclosed type designed for steam working. The gearing is machine cut and all parts are lubricated with a view to giving silent running. The principal point of interest is the adoption of a central rotating steam control valve geared to the control and reversing levers. Steam admitted through the control valve gives a raising or lowering motion, and practically instant reversal can be obtained at any position by moving over the reversing lever. In practice where quick handling is essential, control is carried out by the reversing lever, and the brake effect under a lowering load can be quickly and smoothly applied by opening the valve to steam

in the lifting direction. An ordinary band brake is fitted. The Babcock crude oil engine is illustrated in Fig. 51. It is a 15 brake horse-power two-stroke cycle model with a cylinder bore of 8½in., a stroke of 9in., and a normal running speed of 375 revolutions per minute. As the engine is designed for electric lighting service, a heavy fly-wheel with an outboard bearing is fitted. The general absence of valves incidental to two-stroke design will be noted, and it will be seen that all working parts are particularly well enclosed. The governor is of the crank shaft type

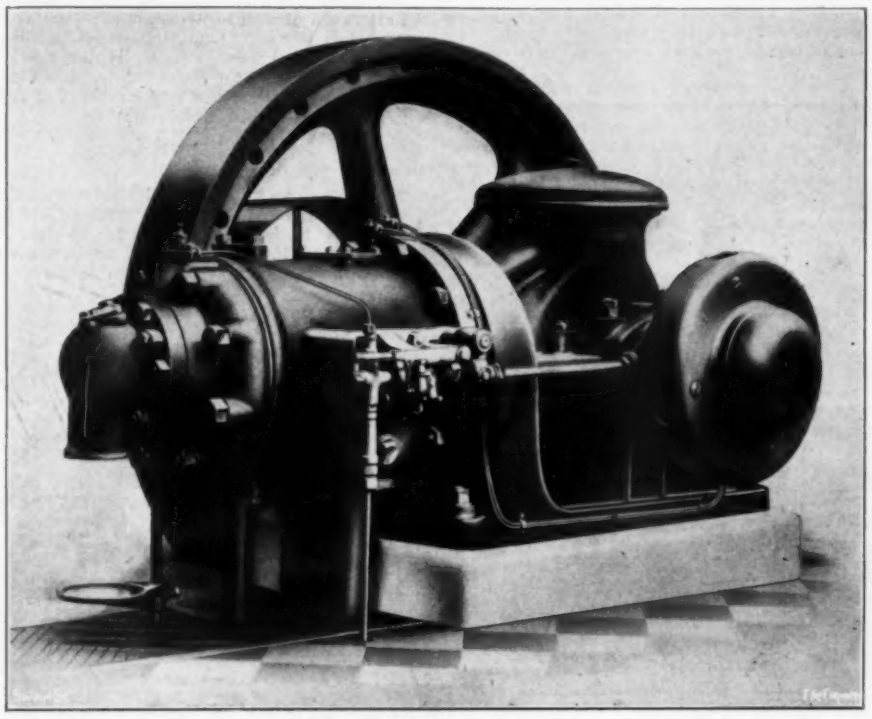


FIG. 51—15 B.H.P. CRUDE OIL ENGINE—BABCOCK AND WILCOX

and it operates directly on the fuel pump. Engines of this type are built in sizes of from 3 to 150 brake horse-power, both for electric lighting and industrial uses.

GEORGE KENT, LTD.

The stand of George Kent, Ltd., of Luton, at any exhibition is always interesting to engineers, on account of the wide variety of metering apparatus

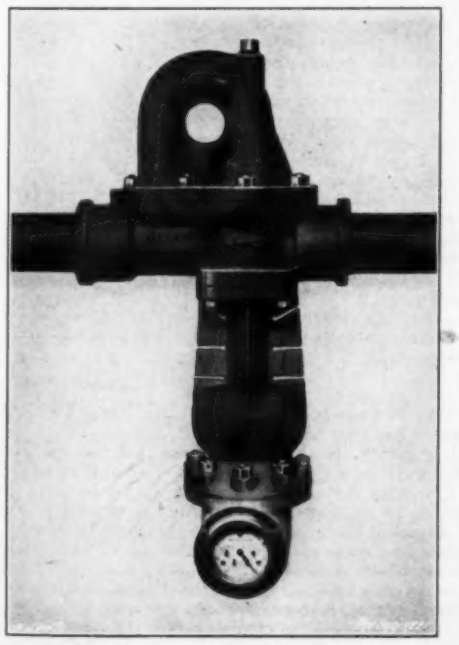


FIG. 52—STEAM METER—KENT

exhibited, and it is unnecessary here to enlarge upon the Venturi, Torrent and other forms of water meters with which our readers are quite familiar. In the direction of steam measuring, this firm has, however, recently brought out a new, simple, form of instrument, of which we gave some brief particulars a few months ago.

This steam meter, of which we give a sectional drawing in Fig. 53, while Fig. 52 gives an idea of its general outward appearance, is of the propeller type. That is to say, the flow of steam actuates a screw propeller, the revolutions of which are a measure of the steam passing.

On reference to the sectional drawing it will be seen that the straight-through passage along the pipe to be metered is restricted by an orifice and that a by-pass is arranged round, and above, this restriction. Incidentally, it may be mentioned that the loss of pressure caused by the restriction is less than 1 lb. per square inch.

In the by-pass there is arranged a screw propeller, on the spindle of which there is a damping "fan." This fan is submerged in the condensed steam, which collects in the surrounding casing and keeps the speed of rotation of the propeller within reasonable limits. In order to transmit the movement of the propeller mechanism to the counter below, the spindles

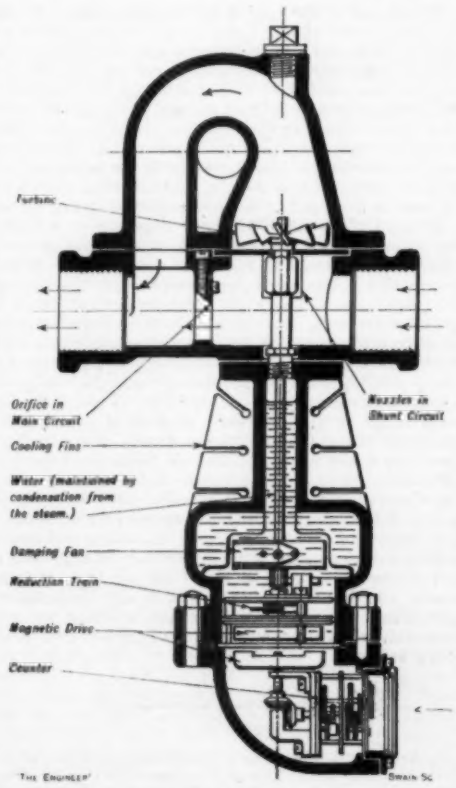


FIG. 53—SECTION THROUGH STEAM METER—KENT

of the two parts are each provided with magnetic arms, and these two arms are arranged on opposite sides of a water-tight diaphragm, so that water is totally excluded from the more or less delicate mechanism of the counter. This drive is quite positive, within the limits required for driving the counting gear, and it is obvious that it is only a matter of calibrating the dials of the counter, against the orifice in the main pipe, to get a measure of the steam flowing through the pipe.

It has occurred to us that, in the event of "dirty" steam, from boilers which were forced severely, being passed through the meter, the accurate indication of the propeller might be affected; but we are assured by the makers that interference from such a cause is not worth consideration.

These meters are, of course, only intended for comparatively small flows of steam, and are made in various sizes for pipes ranging from ¾in. to 2in. in diameter.

There were also on this stand several instruments for electrically recording at a distance the water levels in boilers on both the Avory and Martin principles, and the glass wind screen from which rain or any moisture is thrown by centrifugal force, to which we have made previous reference.

KNIGHT AND SMITH.

A working model of a new form of separator for extracting the oil from dirty bilge water was exhibited by Messrs. R. C. Knight and Dunford Smith, 146, Bishopsgate, E.C. 2, and its general arrangement is illustrated in the line drawing Fig. 54. Broadly speaking, the separator is a combination of an inverted syphon, and a settling tank, through which the oily water is continuously pumped. It will be seen that the top of the inlet leg of the syphon is divided by a

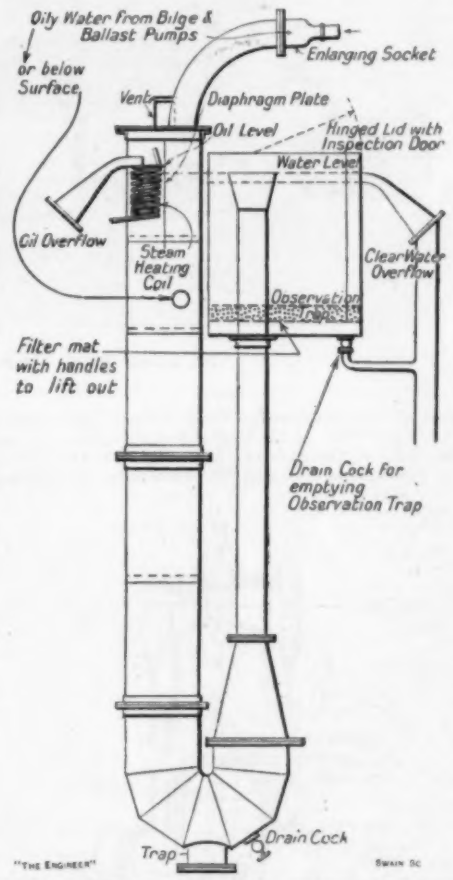


FIG. 54—OILY WATER SEPARATOR—KNIGHT AND SMITH

vertical diaphragm, and the water is delivered to the apparatus on one side of this partition. On the other side there is an outlet for the oil and a steam coil, which may be necessary if the oil is very heavy. The water flows downward through the syphon comparatively slowly, on account of its large cross-sectional area, and the oil consequently has ample opportunity to separate out and rise to the surface. The upcast leg of the syphon is smaller in diameter and terminates in a cone, which can be adjusted, as to height, on a screw. The height of the lip of the cone will naturally be dependent on the specific gravity of the oil floating on the water in the other leg of the syphon and on the rate of flow through the apparatus. The water is discharged by the cone into a tank, from which it passes through a filter pad and escapes underneath a weir reaching nearly to the bottom of the tank, and then overflows overboard.

The intention of the inventor is, of course, to effect the separation of the oil from the water in the downcast leg of the syphon, and the tank is only an added safeguard. Any oil which may pass right through the syphon floats at the top of the tank, and can be skimmed off occasionally. The effectiveness of the apparatus obviously depends to some extent on the depth of the syphon; but we are informed that if space is not available to accommodate a separator of the proportions illustrated it can be shortened without spoiling its efficiency.

In operation, the bell mouth is adjusted to suit the specific gravity of the oil to be extracted, by means of

a special gauge supplied with the apparatus, and the whole is filled up with water. Sufficient oil is then poured into the space on the outlet side of the diaphragm to establish the oil level. Pumping can then be started and the separated oil will be delivered at the proper outlet above the steam coil, while the water is discharged quite clear.

We have inspected samples of oil and water separated by this apparatus, and from these samples have formed the opinion that it is quite effective in operation. It is made in capacities of from 10 to 200 tons per hour.

SULZER BROS.

One of the most interesting of the working exhibits at Olympia is the 300 brake horse-power six-cylinder

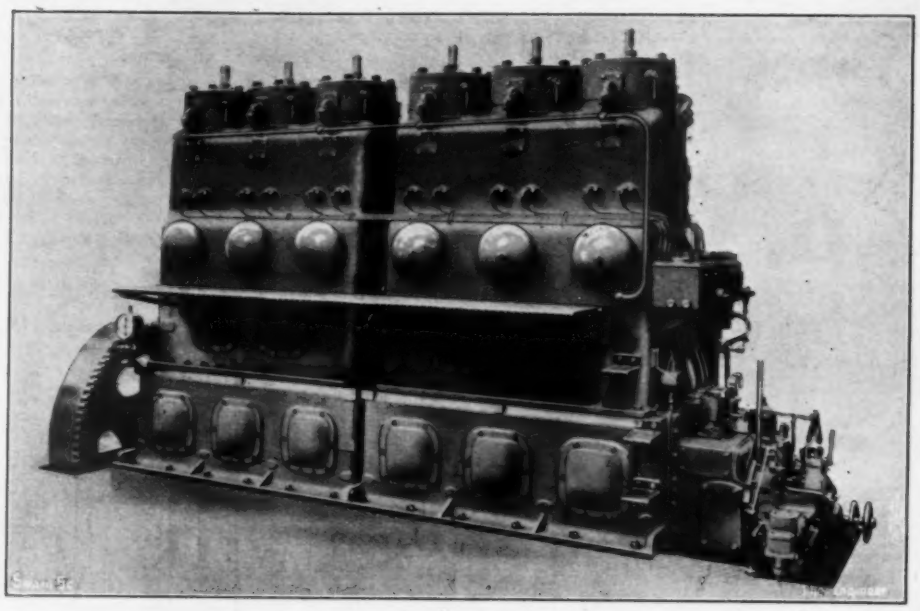


FIG. 55—300 B.H.P. AIRLESS-INJECTION ENGINE—SULZER

airless injection oil engine which is shown on the stand of Sulzer Bros., of 31, Bedford-square, London, and Winterthur, Switzerland. The engine is the first of its size and is designed for stationary or auxiliary

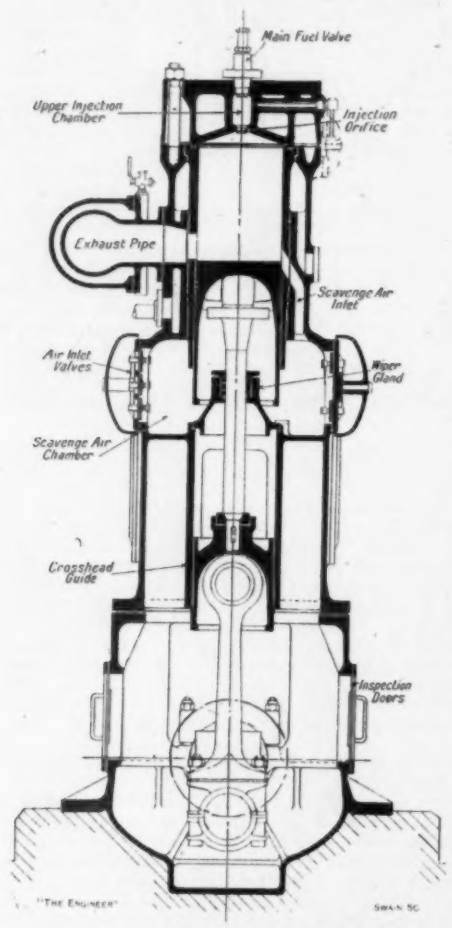


FIG. 56—AIRLESS-INJECTION ENGINE—SULZER

marine service. It may equally well be used, we learn, as a main propelling motor when suitable reversing gear is added. As will be seen from the accompanying illustrations, Figs. 55 and 56, the engine is of the totally enclosed type, and the only valve on each cylinder is an automatically operated fuel valve. For this reason the makers claim it as one of the simplest internal combustion engines yet made. Some of the main features of the design are shown by Fig. 56. The bed-plate is of box form, made in two three-cylinder sections with large inspection doors giving access to the crank pit. A one-piece cylinder and crank casing is employed for each of the two sets of three cylinders, which serves to enclose all the running parts, including the cylindrically guided crossheads and the separate scavenging air chambers, which are fitted below the main pistons and are completely separated from the crank case space. Scavenging air is drawn into the scavenger chambers through two groups of suction valves, each provided with a circular cover plate and arranged one on either side of the cylinder casing. There are six valves to each main group and they are made of leather with a steel reinforcing washer. The suction valves are quiet in operation. At the opposite end from the fly-wheel are grouped mechanical lubricators for the cylinders and running parts, as well as the fuel pumps and the starting controls.

At the end of the engine are two hand wheels, one a locking hand wheel, which enable the operator to control the speed whilst running plus or minus 5 per cent. Such control is useful for paralleling operations on electric generator sets. The fuel pumps, six in number, are arranged radially at the end of the engine; the three pumps serving the starting cylinders are hand controlled and the other three are linked up to the starting handle. When the starting air is turned on one movement of the control handle suffices to start the engine from cold. For supplying starting air at a pressure of about 300 lb. per square inch a small compressor placed on the crank case is arranged to draw its air from the scavenge air supply. When the starting bottles have been charged the compressor can be put out of operation. The fuel valves are of a special type with an upper injection chamber and injection orifice, which gives a graduated and controlled combustion. Before the end of the compression stroke a very small quantity of fuel is injected into the upper injection chamber, and the pressure of the burning gases supplies the necessary additional pressure to overcome the cylinder compression pressure and to spray the main charge of fuel oil from the top fuel valve into the working cylinder. Combustion is thus quite automatic and is controlled by the special design of the upper injection chamber and its orifice. The engine is complete with both oil cooling and water cooling arrangements. When running at full load a fuel consumption of 0·43 lb. of oil per brake horse-power has been obtained, whilst the amount of lubricating oil required does not exceed, we are informed, more than one gallon of oil for over nine hours' service.

AN ALLEN'S DINNER.—The thirteenth annual dinner of the Association of Past and Present Students of W. H. Allen, Sons and Co., Ltd., was held at the Trocadero on Saturday evening, November 28th, and appeared to be more largely attended than heretofore, no less than seventy covers being laid. Mr. Harold Allen, High Sheriff of Bedfordshire, was in the chair, and Mr. R. A. Chattock, president of the Institution of Electrical Engineers, was the chief amongst several important guests. To him fell the honour of proposing the toast of the Association, to which the chairman replied. The Association does admirable work in keeping the old students of the firm in touch with each other and with the directors. It was interesting to find in the gathering the same sort of feeling that one meets at old school dinners, and it did not seem at all surprising that one of the old students should refer to Mr. W. H. Allen as the "head."

Public Works, Roads and Transport Congress.

No. III.*

WE conclude below our summaries of the papers presented at the Public Works, Roads and Transport Congress, which was held at the Royal Agricultural Hall from November 19th to 26th.

LAND SETTLEMENT IN NEW ZEALAND.

The meetings of the Congress were continued on the afternoon of Monday, November 23rd. The first paper taken was on "Land Settlement in New Zealand," and it had been prepared by direction of the Hon. A. D. McLeod, Minister of Lands. It is a lengthy document, and by far the larger portion of it deals with matters which are outside our sphere.

SMALL HOLDINGS.

The next paper, "Are Small Holdings of Private Owners and County Councils in England and Wales essential to National Prosperity?" by Mr. F. H. Osmond-Smith, F.S.I., county land agent, Glamorgan, also deals with matters which are not within our province.

HIGHWAYS.

Three papers were down for consideration on the morning of Tuesday, November 24th, when the meeting was held under the auspices of the Associations of Local Authorities. All three papers had to do with highways, and, quite fittingly, the chairman was Sir Henry Maybury. The first paper was on "Trench Openings in Highways," and it was by Mr. Roland Fletcher, Assoc. M. Inst. C.E., the borough engineer and surveyor, Smethwick, who said that the public at large was apt to blame the highway authority—and almost invariably through their engineer—for all defects in road surfaces, but that while the engineer was responsible for the maintenance of the surface of the highway, he, unfortunately, had not the control of trench openings which he would like, or which would appear to be desirable. In his own county borough the question of trench openings had been so acute of late that he had often been tempted to refer to the question as "trench warfare," and certainly some of the gas and other departments had caused the highways to suffer severely from "trench fever." Unfortunately, highways could not be inoculated against the disease, and the highway engineer had perforce to turn his attention more to the cure of the malady than to its prevention.

The author said that, speaking generally, he considered that anyone breaking open a highway should be compelled (1) to carry out the work with a minimum of inconvenience to road users; (2) temporarily to make good the surface so as to render it perfectly safe and to maintain it in a safe condition until permanent reinstatement took place; and (3) after a suitable lapse of time permanently to reinstate the road surface foundation to a condition as nearly as possible conforming to the state of the surface and foundation before the operations commenced. In practice, he had found that the majority of contractors or others doing the work made a serious endeavour to carry out condition (1) satisfactorily to everybody concerned. With regard to condition (2) he could not go quite so far, and had found a great tendency to slackness on the part of certain contractors who failed to realise the enormous difference between road conditions, say, twenty years ago, and those obtaining to-day. With regard to condition (3)—permanent reinstatement—he held very strongly to the opinion that only the highway authority could and would properly and efficiently carry it out.

The author then went on to discuss various aspects of reinstantement of roadway surfaces after disturbance.

The next paper was on "Public Utility Services under Highways," by Mr. G. P. Warner Terry, who is secretary, British Waterworks Association. The first portion of this paper, which is a corollary to that of Mr. Fletcher's, is a commentary on the second part, which is an appendix containing a summary of a "Digest of Statutory Rights to Break-up Highways," that has been prepared for the use of the British Waterworks Association. In his opening paragraph, the author explained that, as that Digest was only bare law presented in the most colourless way, he had been asked to express his own views on the matter in an unofficial way, mainly with the object of provoking discussion. He knew, he said, that he would be quarrelled with, but it was one of the uses of such gatherings, as that which he was addressing, that officials could present their own opinions without committing anybody officially; and perhaps serve some useful purpose by reminding those who needed it that there were always two sides at least to any question; and that mere clamour or noisy iteration did not strengthen any argument, however popular or agreeable to the fashion of the moment.

However "bare" and "colourless" the Digest

* No. II. appeared November 27th.

may be, those epithets cannot certainly be applied to the commentary on it, for it is delightfully well written, and contains a large amount of interesting historical and other matter. It does not, however, lend itself to condensation, but should be read as a whole, and we must content ourselves by giving one short abstract from it.

It is as follows:—"A great deal of nonsense is talked by highway enthusiasts and motor maniacs, when claiming that the highways strictly belong to those who may be termed the 'surface users,' and that the 'sub-surface users' are interlopers and trespassers whose rights, conceded by purblind Parliaments in the past, have reluctantly to be acknowledged.

"When loose talk is indulged in to the effect that the sub-surface interests are only in possession of 'statutory easements'—whatever that may mean—it is as well to remind those concerned that highway authorities themselves only possess a vested interest in so much of the sub-soil as is necessary to keep up the highway and so much of the superincumbent column of air as is necessary to admit of traffic of a normal height. Of course, the highway authorities do not own the highways. . . . As a matter both of history and of law, the view that the highway is only for surface users is utterly wrong. In ancient times the aqueduct often preceded the road or viaduct. It was recognised that you cannot have human habitations without a water supply or, in a lesser degree, its complement the sewer. It is to be commented upon that a Ministry of Health allows houses to be put up without requiring the local authority to see first that there is a water supply available."

The third paper was on "The Use of Tar in the Construction of Roadways," and was by Mr. Thomas Glover, M. Inst. C.E., of Norwich, and Mr. Arthur E. Collins, M. Inst. C.E., of Colchester. It was explained at the outset that the paper was offered on behalf of the Institution of Gas Engineers, the members of which were responsible for producing a large proportion of the raw material from which the prepared tar for road dressing and road crust construction was derived.

The authors remarked that, if the question were fairly considered, they ventured to say the overwhelming conclusion would be that tarred road surfaces were a success, and that the practice of dressing roads with suitably prepared tar—followed by the application of stone chippings in sufficient quantity to form a compact wearing layer—had resulted in the abolition of dust on the highways, and that it had, until recently, been the only means available to the road engineer for keeping the majority of road surfaces in a usable condition, whilst tar dressing of road surfaces had been practised in England for over half a century. In seeking to allay dust by the use of tar, the penetrating quality of the oils in the tar had a distinct attraction for the road engineer, who was then dealing almost entirely with water-bound roads. The adhesive resinous part of the tar, however, was found to have considerable protective qualities in preventing the attrition of the aggregate forming the road crust, and a demand soon arose for a quality of tar having a higher percentage of the adhesive resins and a lower percentage of the volatile parts of the tar, which was found to be of great value as a binding agent for surface dressing and in the tarring of aggregates for tar-macadam work. Local supplies of tar had advantages for engineers in urban communities; and the gasworks which existed in every town of any size in England, Wales and Scotland, were called upon either to put in distilling plants or get the tar treated for the removal of the highly volatile naphthas and oils. Where the process had been carried out with care to comply with the specifications which were afterwards forthcoming from the Road Board, the results had been, with few exceptions, highly satisfactory. An investigation into the causes of these exceptions would have revealed the reasons for imperfect results, viz., either the use of tar of inferior or irregular quality, faulty aggregates, incorrect manufacturing conditions and incorrect application of the materials, whether in the form of tar-macadam or surface tarring.

Prejudice had been raised against coal tar on the ground that washings from roads made or surfaced with it injured fish and aquatic vegetation. That was possible that in some special cases that might be true, but on the vast majority of our roads it was not the case, and no sufficient reason existed for excluding tar therefrom.

Strengthening Bridges.

In the afternoon the conferences had been arranged by the Institution of Municipal and County Engineers, and were under the chairmanship of Mr. Frank Massie, M. Inst. C.E., the President of the Association, who is Surveyor to the Wakefield Rural District Council. Two papers were presented, and the first was on "The Strengthening of Bridges," and was by Mr. C. G. Mitchell, A.M. Inst. C.E., and Mr. C. S. Chettoe, A.M. Inst. C.E., both of the Roads Department of the Ministry of Transport.

The authors explained that for the purposes of their paper bridges might be divided into the following types:—

(1) Brick or masonry arches.

(2) Wrought iron or steel bridges, which could be subdivided into—

(*a*) Trough bridges.
(*b*) Multi-main girder bridges with plate girders or joists.
(*c*) Through or deck main plate girders with cross girders and stringers.
(*d*) Truss bridges.
(*e*) Arches.

(3) Cast iron bridges, which could be subdivided into—

(*a*) Beam bridges.
(*b*) Arch bridges.

(4) Suspension bridges.
(5) Reinforced concrete bridges.

They then proceeded to describe various methods by which existing bridges, which were unable to bear the loads of present-day traffic, might be strenghtened. They did so by the aid of numerous diagrams, and as we cannot spare space to reproduce them, and as a *résumé* of the text would be of but little use without them, we must leave it to those of our readers who are interested in the subject to obtain a copy of the paper and study it as a whole.

Road Corrugation.

The next paper, which was on "Road Corrugation," was presented by Mr. E. L. Leeming, M.Sc. Tech., Assoc. M. Inst. C.E., who began by saying that with the advent of improved road construction and of motor transport there had developed a curious feature of wear which was generally known amongst road engineers as "road corrugation." The waviness should not be likened to "rail corrugation," which was caused by entirely different traffic and track conditions. The fixed wheel and axle rotation on rail traffic resulted in a side skid, owing to one wheel alternately getting ahead of the other; also in rounding curves there must be a further slip and skid, as the distance along the outer rail was greater than that along the inner one. For that reason, rail corrugation was frequently to be found on tramway curves. On roads, however, the engineer was confronted with different conditions of traffic, and of the road itself at every section of it. A tar-macadam road which in one county was smooth and practically free from waves, would show corrugation if laid in another county, even though the same material were used.

The wave trouble had come with the introduction of mechanically propelled traffic. It followed, therefore, that it must be due to some particular feature of that traffic. The motor omnibus was a vehicle driven from the back axle, and usually equipped with solid rubber tires, a combination which inflicted untold damage to the road. The rear axle drive was perfect only so long as the road was perfectly smooth, but even the best road did not possess that smoothness, with the result that vibration due to the drive was set up. On a smooth surface presenting an even tractive resistance, the drive at the wheel contact was horizontal, and its transmission to the vehicle was likewise horizontal. But no road offered a constant tractive resistance, and therefore a great deal depended on whether the variations were slight or serious. In the ultimate, when the rear wheel struck the opposite slope of a pothole or wave—and, in fact, the action was the same when tractive resistance increased—the drive was then partially upwards, and that sets up a periodic vibration which was easily repeated. Clearly the solid rubber tire, quickly shorn of its resilience by pressure and wear, was incapable of taking up those road inequalities, and the action was complete.

Occasionally we noticed that, on the same road and under apparently similar conditions, the frequency of the waves varied although the damage was caused by the same class of vehicle. The explanation of that was that, as the frequency varied, so did the depth and shape of the wave and the initial cause—in the road—of the vibration. Another cause of the varying shape of the waves was the position of the road; waves in the middle of a 20ft. road were of a different shape from those at the side or where the wheel traffic was all in one direction.

The habits of vehicles were mainly governed by the volume of traffic; on the quieter roads the vehicle usually sought the centre, and excessive wear was experienced. A small cambered road would assist in baffling drivers as to the centre of the road. Heavy motor omnibus vehicles did not travel well or safely if they were entirely on the left half of the road, and the rear or driving end tended to swing into the channel. That condition of things imposed great strain upon the road and created a corrugating vibration on the inner portion of the vehicle. Speed under those circumstances added to the destructive effect and to the danger from skidding.

The road engineer would usually testify to the increased expenditure incurred at the bends of a road; the road user would testify to the rough surface, potholes and waves which he had to negotiate at curves. There was one short remedy for that state of things, and that was to construct the surface levels so that there was a gradual change from the cambered section on the straight to a super-elevated section on the curve.

Corrugation on hills depended very largely upon the gradient, the width and alignment and the nature of the surface material. Downward traffic exerted a great thrust or shear downhill, as also did the up traffic; the former was generally the more destructive of the two, because speeds were higher and brake action inflicted serious damage to the upper layer of road material. Up traffic was steadier by reason of the increased drive and reduced speed. On gradients, generally speaking, all traffic tended to move to the centre and thus to cause greater wear on the centre portion of the road. As a rule, the shape of the waves would be flat on the upper side and steep on the lower side, owing to the continual creep downhill, and there again the solid rubber tires were the most destructive in causing this waviness.

It was a matter of some difficulty to diagnose the reasons why some tar-macadam roads resisted wave formation and others apparently made in the same way did not. Roads repeatedly tar-sprayed often worked up into waves independently of the original surface; in such cases scarifying would remove the trouble. Large aggregate tar-macadam would resist movement better than small aggregate; finishing coats of fine Tarmac should be applied sparingly, so that it did not leave surplus material without a proper key. Bituminous asphalt about 2in. thick, when laid on concrete, withstood wave action with great success.

To meet the troubles, Mr. Leeming suggested that solid rubber tires should be more heavily taxed; in other words, taxed more nearly in proportion to the damage done. It was deplorable that pneumatic-tired vehicles should be paying at their present rates for the damage caused almost entirely by the solid-tired vehicles. A reduction of tax for pneumatic tire equipment would immediately take effect, and road damage would be substantially lessened. That, in turn, would mean a less expenditure in road upkeep, which would equalise any diminution of revenue caused by the concession.

If pneumatic tires were not to become universal, then some improvement on the present rear axle drive would appear to be necessary. Actually, it would damp vibration considerably if the load could be pulled from the front axle instead of pushed from the rear. Six-wheel vehicles were a step in the right direction, and particularly those which provided four driving wheels. Anything which carried the load on six wheels—even though the load were greater than one on four wheels—must make its weight ride steadier along the road surface.

Gas Lighting.

The morning session on Wednesday, the 25th inst. was in charge of the Institution of Gas Engineers, and was presided over by Mr. C. F. Botley, the President of the Institution, and chief engineer to the Hastings Gas Company. Of the three papers considered the first was on "Public Lighting by Gas, with Special Reference to Automatic Systems," by Mr. Charles S. Shapley, engineer and general manager, gas department of the Leeds Corporation.

After a general review of his subject, Mr. Shapley proceeded to say that to get the best value out of any service it was necessary to make full use of the available energy without waste, and that it was apparent even in the earliest days of street lighting that there was a tremendous waste of luminous energy owing to the time taken by the lamplighter between lighting the first and last lamps on his beat. It was necessary under that system to light the majority of the lamps during daylight hours, and the same waste of lighting occurred at extinguishing time. It was obvious that that waste of money and energy, if checked, could be used to lessen the cost of street lighting to the ratepayer, or, on the other hand, for the same expenditure better service could be given. It followed that the introduction of some kind of control was the inevitable order of progress, and we found that what were now known as automatic controllers were mentioned so far back as June 20th, 1868.

The remainder of the paper was taken up by descriptions of various types of controllers.

The Rating of Gas Undertakings.

The second paper was "The Valuation of Gas Undertakings for Rating Purposes," by Mr. George Evetts, M. Inst. C.E. It deals with a subject, which, although it is of interest to many engineers, hardly comes within our province, and we do not, therefore, propose to give an abstract of it.

The Uses of Electricity.

The afternoon session had been arranged by the Incorporated Municipal Electrical Association, and was presided over by Mr. R. B. Mitchell, engineer and manager of the electricity department, Glasgow. There was only one paper, "The Uses of Electricity for Housing and Institutional Purposes," by Mr. R. Hardie, A.I.E.E.

After a brief reference to housing in general, the author went on to ask why to-day, when even tenants of older houses were discarding gas and installing electric lighting at their own cost, we should incur the cost of installing lighting equipment which had been scrapped in every progressive country? In our Colonies, on the Continent, all over North America, electric lighting was fast becoming universal, not only in every class of residence, office, workshop and factory, but for the lighting of all urban highways. Light-

ing superintendents would bear him out when he said that the existing lighting of many of our main streets, and practically all our side streets, left much to be desired. In but few of our city thoroughfares was the present standard of illumination anything like adequate; probably early developments in electric lamps of greater efficiency would help us to settle the question once and for all, and render past controversies on gas *versus* electric street lighting superfluous. He was assured that it was only the lack of funds which prevented this subject from being tackled by the officials responsible.

The author then went on to discuss the various uses to which electricity could now be put in the household, and concluded by saying that the electrical industry had long since divested itself of swaddling clothes, and with the supreme confidence of young manhood it was seeking an opportunity to make good its claims, satisfied that performance would justify them.

ROADS.

The session on the morning of Thursday, November 26th, had been arranged by the Institution of Municipal and County Engineers, and the chairman was Mr. Frank Massie, M. Inst. C.E. There were two papers down for consideration, of which the first was "The Repair of Roads Against Tramway Tracks," by Mr. Francis Wood, M. Inst. C.E., borough engineer and surveyor of Blackpool, who said that the problem of tram rails in the road surface was one that had caused much discussion—on the one hand by road engineers and those interested in vehicular traffic generally, and, on the other, by tramway managers and those interested particularly in tram traffic. The latter argued that the most economical method of conveying the public in large numbers from one point to another was by means of tram cars on rails, and that local authorities should be grateful to the tramway undertakings because, as was usual, the tram rails occupied the centre of the road, which area was maintained by them, the highway authority was relieved of the expense of maintaining the portion of the road in which the rails were laid. Road engineers, on the other hand, were unanimous in declaring that tram rails were a continuous source of trouble and annoyance to ordinary vehicular traffic and that they should be eliminated from any road surface over which other vehicular traffic passed. Resolutions on those lines had been passed at two meetings, at least, of the International Road Congress.

As to the local authorities saving half the cost of maintenance, that was an erroneous deduction, based probably on an arithmetical calculation instead of actual experience. There might be some saving, but, in general, it did not amount to such a proportion as one half the total cost of maintenance, the reason being that the tram rail wore to a very small extent—during a period of twenty years under heavy traffic, there was not half an inch of wear—whereas wood paving, for example, would wear about 2in. to 2½in. in a less period in a road with no tram rails, but where there were tram rails and there was a frequent service of cars, the ordinary traffic was forced to the sides of the road, where tracking took place, with severe wear and to such an extent that the paving had to be replaced in about half the period it would otherwise have lasted; hence, with such a pavement, the maintenance of half the road was actually more costly than maintaining the whole. With macadam similar results obtained. Road engineers had been studying the problem with the object of securing a surfacing mixture that would not wear so rapidly as wood paving; at one time it was thought that granite setts would solve the problem, as the wear of that material approximated to that of the steel rail, but the ordinary granite sett had not been successful.

On the question of economy, probably it would be admitted that where there were great numbers of passengers to be conveyed the trams could deal with them more expeditiously and economically—it might be with less number of vehicles, because the number of passengers might reach a higher figure than 100 per car; but it was not usually the case that the density of the tram traffic was maintained throughout the day at that rate, and on many occasions there were very few passengers for the huge cars, which were used during the whole of the day, and thereby unnecessarily occupied an important area of the road.

Mr. Wood then went on to discuss various methods of track construction, and the surfacing of the road, and concluded by saying that he was convinced that the rigid form of track construction that had been followed in the past would quickly cause corrugations to form on the rail surface where there was heavy and continuous car traffic passing over the track, and that for comfortable running and less costly maintenance it was necessary to provide a resilient foundation or a resilient bed on which the rails might be allowed the very slight movement which it required and which would bring the rail back to its normal position.

The second paper was entitled "Scottish Rural Roads: A Suggested Policy for the Future," and was by Major W. L. Gibson, county road surveyor, Perthshire County Council, Western District, and Mr. George S. Barry, county road surveyor, Ayrshire County Council, Ayr District.

It is a thoroughly practical paper which deals with the various aspects of road construction and maintenance in the light of the extended experience of the two authors. The subject is discussed under five headings:—(1) Road surface maintenance; (2) crust formation; (3) dangerous corners and narrow roads; (4) footpaths; and (5) capital expenditure, central quarries, and other matters.

With regard to the first, the opinion was expressed that the timeous patching of potholes and the making up of depressions could not be too strongly urged. It was unfortunately the case that often when men and plant were engaged in coating operations, ordinary repair work was apt to be neglected. Sometimes that was due to want of sufficient funds, and pointed to the need for squads more or less permanently engaged upon minor repair work and to the provision of an adequate allocation of expenditure for this work. The authors were satisfied that if a district were split up into two or more divisions, according to its size, and if in each division there were a small squad provided with suitable plant and materials, detailed to carry on the repair work systematically, a great deal of surface wastage could be checked and much improvement effected.

After reviewing the qualities of various materials used for crust maintenance, the authors then turned to crust formation, and said that a surface that was durable and reasonably inexpensive was to be aimed at for main roads in rural areas. Three forms of construction suggested themselves, viz.—(*a*) tar-macadam sealed with tar and bitumen compound; (*b*) dry metal grouted with either tar-bitumen compound or pure bitumen and sealed with a similar medium; and (*c*) a modification of (*b*) where the newly metalled surface, after a thorough consolidation with the roller, received about half a gallon of grout per square yard, and was finished off with ¼in. or ⅜in. chippings or rough gravel well rolled in. That particular form was recommended as suitable for moderately heavy trafficked roads, and as a substitute for water-bound macadam tar-sprayed. While the cost is approximately the same as the latter, the "semi-grout" method provided a much better road. In some districts the (*a*) type of construction would not be found so convenient as the (*b*) type, but where no central tar-macadam plant was in existence, a good portable plant should be obtained. Special attention must be directed to the haunches of the road, for therein lay the weakest part of a rural road. The sides should be taken out to a depth of 10in. to 15in., and filled in with slag or whinstone bottoming well consolidated.

Other matters in connection with road and footpath construction were also discussed.

The last session of the Congress, on the afternoon of Thursday, November 26th, had also been arranged by the Institution of Municipal and County Engineers, and was also under the chairmanship of Mr. Frank Massie. Two papers were taken, the first being "Regional Planning and Road Development," by Mr. Herbert H. Humphries, M. Inst. C.E., the city engineer and surveyor of Birmingham.

The author said that the matters to be dealt with in connection with town-planning schemes, such as the planning of road and street systems, general transportation, water supplies, natural and artificial drainage, lighting and power distribution, refuse disposal problems, the provision of recreational and educational facilities, industrial and residential zoning, the establishment of civic and neighbourhood centres, &c., were obviously of such importance to the welfare of the community generally that they could not be exclusively designed within the compass of the arbitrarily fixed boundaries of separate local authorities. To attempt to do so, must, of necessity, end in failure to provide the best services to the particular district itself, while possibly seriously hampering the development and other interests of the adjoining region.

As those were all matters the successful solution of which was vital to the well-being of a whole region, it was a matter of paramount importance that the planning of extensive areas should be undertaken, extending and co-ordinating the town-planning schemes of the various authorities within it. Thus would be produced one comprehensive and coherent scheme for the whole of a region which, owing to its geographical and physical features, had such important matters in common as those above mentioned, conjoined to mutual manufacturing, trading and business interests.

The last paper was entitled "Housing: A Brief Review of some Modern Methods of House Construction," and was by Mr. Percy Morris, the city housing architect of Wakefield.

It is a lengthy paper, containing a vast amount of useful information, and profusely illustrated by drawings and half-tone engravings, and it does not lend itself to condensation. As space precludes us from reproducing it in its entirety, we are reluctantly compelled to do no more than mention it.

A SOCIETY has been formed in Chili, under the name of the Asociación Carbonera de Chile, for the purpose of developing the vast coal resources in the southern part of that country.

Carborundum.

THE history, methods of manufacture and applications of carborundum formed the subject of a paper read before the Manchester Association of Engineers on Friday, 27th ult., by Mr. F. W. Higgins. The author said that carborundum had never been found in Nature, but was solely a product of manufacture in the electrical furnace. It was first produced experimentally in 1891 by Mr. E. G. Acheson, and so rapidly had its uses been developed that to-day the annual production was upwards of 30,000 tons.

Carborundum, the author went on to explain, was manufactured in electric furnaces of the resistance type, the furnaces consisting of a rectangular fire-brick box-like structure, 45ft. long, 10ft. wide and 10ft. high, through the two ends of which were passed carbon electrodes connected by copper cables to the electric power line. The furnace charge consisted essentially of silica, sand and finely ground petroleum coke, to which were added small amounts of sawdust and common salt, the object of the sawdust being to facilitate the escape of the carbon monoxide gas while the salt acted as a purifying agent. The furnace was operated intermittently.

In preparing for a run, the mixture was led into the furnace until it was about half full, and a trench was then made from end to end, which was filled with granular coke. The coke formed a core which made connection with the electrodes at either end, and constituted the resistor. The furnace was then filled with the remaining mixture, and the power turned on. The current of 10,000 ampères was transmitted through the core, which was thereby raised to an incandescent heat, and, in turn, radiated that heat to the surrounding mixture. As the temperature increased, the reaction between the coke and sand proceeded, with the resultant building up of a ring of carborundum crystals surrounding the core. The oxygen of the silica combined with carbon to form carbon monoxide which escaped as gas, burning to carbon dioxide on the surface of the furnace. The silicon simultaneously united with the remainder of the carbon present to form silicon carbide. The reaction in effect was expressed by the equation—

$$SiO_2 + 3\,C = SiC + 2\,CO.$$

The formation temperature of silicon carbide was 1840 deg. Cent., and it was decomposed above 2240 deg. Cent. Outside the zone of crystalline carborundum, there was produced a ring of amorphous carborundum, consisting of an indefinite combination of silicon carbon and some oxygen. If the temperature of the core exceeded 2240 deg. Cent., some of the carborundum crystals next to the core were converted into graphite, owing to the decomposition of the silicon carbide molecule; the silicon was volatilised, leaving the carbon as a graphite pseudomorph of the carborundum crystal. On that discovery Acheson founded the artificial graphite industry. The phenomena was remarkable in that a material which represented almost the extreme limit of hardness was thus suddenly transformed into one which possessed the extreme of softness; for graphite was so soft that it found favour as a lubricant—the very antithesis of an abrasive. The present-day furnaces consumed 3000 horse-power each, and produced 8 tons of carborundum in thirty-six hours. At the same time, over 11 tons of carbon monoxide gas were given off, and allowed to go to waste by burning on the surface of the furnace. No practical means had yet been found whereby that gas could be collected and made use of. When sufficiently cool, the walls of the furnace were partially removed, the unconverted mixture on the outer portion of the furnace was raked off, a careful separation was made of the layer of amorphous carborundum and, finally, the zone of crystal carborundum was broken into, the carborundum being removed in large irregular masses of interwoven crystals. These masses were transferred to the crushing plant, where they were ground in heavy mills and then passed through a number of processes of refining and grading into the various grit sizes required.

THE PROBLEM OF BRITISH INDUSTRY.

"THE Problem of British Industry" was the title of an address given on Wednesday last, December 2nd, before the Liverpool Engineering Society by Sir Wm. Peter Rylands. Sir Peter began by saying that there were three main factors underlying this problem, which acted and re-acted on each other. They were as follows:—First, the sociologic aspect; secondly, the economic effect of fluctuating currency; and, thirdly, the economic effect of the war upon Great Britain. Sir Peter presented a thoughtful review of the subject under each of these headings, and in his conclusion said that it was a curious economic paradox that the prosperity of the country should be increased by the relief of men who were unemployed. The fact was the country was pursuing two diametrically opposite policies at the present time. On the one hand, we had sought to increase the value of the pound with the idea that that would reduce prices, and to insist that everybody should reduce their costs in order to bring them down to the continental level, while, on the other hand, the more successful we had been in bringing about the necessary depression of trade, the larger the sums of money we provided for the unemployed and for the purpose of relief works to counteract the economic consequences. The essential lesson, he pointed out, was that abounding prosperity of the home trade was able to provide the necessary production more than to make up for the deficiencies in our exports. That suggested that we should seriously consider whether we had been right in the past in regarding our foreign trade as the first interest of the country, or whether, in view of the present position, it might not now be desirable that this general policy should be reviewed, and while seeking, as far as possible, to do nothing which would directly prejudice our export trade, we should now regard the development of the home trade as the first consideration.

Railway Matters.

CLOSER examination of the parliamentary proposals of the Metropolitan Railway shows that, in addition to the new line mentioned in this column last week, it is proposed to revise the powers to extend the Great Northern and City section from Moorgate to Lothbury. We notice also that though the new line between Willesden Green and Edgware-road will be of the tube character, its dimensions will be such as to accommodate the Metropolitan main line coaches. One of the Southern Railway schemes is to give a curve between the South London and the Crystal Palace lines near Peckham Rye.

THOUGH the late Cambrian Railway was comparatively very impecunious, it did its best to develop the coast line between Aberystwyth and Pwllheli, and the people so served were very grateful and appreciative. Under grouping, the line passed from the Cambrian Company to the Great Western Company, but local touch was retained by the line remaining under the supervision of the former Cambrian superintendent at Oswestry. That, however, as regards the line between Barmouth and Pwllheli, is to be changed from January 1st, as that section is then to pass to the supervision of the Chester divisional superintendent.

To reduce the congestion between Waterloo and Hampton Court Junction that has prevailed since the new electrical services were introduced on July 12th, the Guildford, *viâ* Claygate, electrical trains have, as from Tuesday, the 1st inst., been running over the main lines. In order to avoid interference with the other trains on the main lines, they do not call at any intermediate station between Waterloo and Surbiton in either direction. There are now three electric trains to and from Guildford per hour, and three to and from Leatherhead. Two of the latter three serve Dorking and the remaining one Effingham Junction, *viâ* Bookham.

AN important change is being made at the New Year in the administration of the civil engineer's department of the Great Western Railway. Two years ago, when Mr. Grierson retired, Mr. J. C. Lloyd, the permanent way engineer, and Mr. W. Waddell, who had been the general manager, and formerly the chief engineer, of the Barry Railway, were made joint chief engineers. It is now announced that Mr. Lloyd is to be the chief engineer as from January 1st. It is further announced that Mr. R. Carpmael, who was Mr. Waddell's assistant, at present at Barry, and Mr. E. G. Matheson, now the divisional engineer at Bristol, are to be assistant engineers at the headquarters at Paddington. Mr. Matheson is being succeeded at Bristol by Mr. A. S. Quatermaine, now an assistant to Mr. Lloyd at Paddington.

THE use of an increased number of sleepers to permit of a heavier axle load cannot, says Mr. A. F. Harvey in a paper entitled "Sleeper Spacing and its Effect on the Maximum Permissible Axle Load," which has just been issued by the Railway Board, India, be justified in the case of new track to be laid or of relaying existing track with new rails. It might, however, be worthy of consideration in two cases, viz., if it is proposed to run heavier axle loads over existing track, which is not otherwise due for immediate relaying, or if it is proposed to use, for a new line or for relaying, second-hand rails in stock, which it is desirable to use up, instead of buying new rails. In these cases the provision of extra sleepers per rail length might be considered, but this by itself would not be an economical solution, and would have to be accompanied by some restriction in speed as well. These two methods of improving the carrying capacity of the rails, if combined in a reasonable manner, might result in an economical solution of the problem of how to increase the maximum axle load without using a heavier section of rail.

WHEN the apparently large number of railway accidents in France was under discussion, it was stated that more automatic signal sections were to be installed. That was very interesting news, as at one time automatic signalling was not viewed with favour by French railway officers. For instance, M. Margot, now the general manager, but at that time the superintendent of the P.L.M., reported to the International Railway Congress of 1905 at Washington that he was opposed to automatic signals because they could not do certain things that a signalman could, i.e., send a message in case of an accident, stop a train in an emergency, or advise the next box to pull up a train in case of a fire or shifted load on a wagon. M. Margot could speak with sound experience, as 38 kiloms. between Laroche and Auxerre had automatic signals. On the neighbouring Midi, 42 kiloms. between Bordeaux and Langon were equipped. But apparently there has been a change of view in that matter, as, according to a report to the recent London Railway Congress, there are 655 kiloms. (409 miles) equipped on the Midi, whilst the P.L.M. has several intermediate sections with automatic signals.

IN this column of our issue of the 13th ultimo, it was mentioned that when Parliament reopened Lord Monkswell intended to raise certain questions as to the running of trains. That opportunity presented itself on the afternoon of yesterday—Thursday—week, when, on the point of failing to give precise instructions to drivers as to the making up of lost time, Lord Monkswell was effectively answered by Lord Montagu of Beaulieu, who said that it was far wiser not to issue such precise instructions, but to leave the question to the judgment of individual drivers. Those men were thoroughly equipped by their training, and he would rather trust to their judgment than to any mechanical device or precise instructions. Viscount Peel, in answering for the Government, said that the definite orders issued to French drivers were absolutely unsuitable for this country, and the Government thought it very undesirable that such definite and complicated instructions should be given to British engine dirvers as to what they should do in cases of emergency. Another grievance of Lord Monkswell was that mechanical safeguards against excessive speed on sharp curves and other danger points had not been adopted. In our own notice of November 13th we pointed out that "speed control" would not provide for varying limits of speed. Lord Peel, in his reply, did not enlarge on that point, but simply said that suggested improvements were continually being examined by railway companies.

Notes and Memoranda.

THE latest news from Tasmania suggests that the cement works at Railton, where a powdered fuel plant has been installed, will start work this month.

THE Barlow airship station near Selby is to be used as a beet sugar factory, with a capacity of 1000 tons of beet a day. A shipping wharf is to be built on the river Ouse.

A NOTE in the *South African Mining and Engineering Journal* states that a deposit of wolfram of good quality, which is believed to be of considerable extent, has been found near Kenhardt.

THE phosphate deposits of the Malmesbury district of South Africa, which are about 5ft. thick, are said to be "inexhaustible during the present century." The material, according to Mr. Muller, contains 25 per cent. of phosphoric oxide.

IT is announced in the *Chemical Trade Journal* that a British firm has put on the market a solid form of hydrogen peroxide, which should prove a very useful reagent in analytical chemistry. The commercial material contains 35 per cent. of H_2O_2.

DURING the year 1923–24 the mineral production of Tasmania was valued at £1,335,244, as compared with £1,068,178 for the previous year. The most important item was copper at £436,235, while tin came next with £257,797. There were large increases in the production of cadmium, zinc, and cement.

IN the course of a paper read before the Institution of Welding Engineers, Mr. A. E. Knowles, said that his firm opinion was that the use of the surplus power of our power stations in electrolytic cells was the solution of the problem to meet the rapidly increasing demand by chemists for absolutely pure hydrogen in the many synthetic and catalytic processes which were now coming to the front.

IN the course of a paper on "The Education and Training of Mining Electrical Engineers," which he read before the Association of Mining and Electrical Engineers at Cardiff, Mr. T. J. Nelson said that he found students who had passed an examination equivalent to the "London Matric." were better able to grasp the technicalities of their subsequent training than were others not so well equipped.

ACCORDING to the report of the Ceylon Plumbago Merchants' Union, the demand for Ceylon plumbago has shown a gratifying improvement on last year in exports and prices. During the six months which ended with June, 1925, an increased quantity was taken by Germany, which is likely to be the biggest buyer of Ceylon plumbago; up to June 30th it had taken 2900 tons, against 900 tons for the same period of 1924. The demand from America and Great Britain has been disappointing, but a better demand from America is anticipated.

A PAPER on "The Support of Underground Workings in the Coalfields of Scotland" (Safety in Mines Research Board paper No. 12, H.M. Stationery Office, Adastral House, Kingsway, London, price 2d. net) has just been published. This paper is the second report of the Committee appointed to investigate methods of reducing the number of accidents due to falls of ground in coal mines, the cause of half the total number of fatal accidents. In the present report the Committee gives an account of the best practice for supporting the workings in the Scottish mines and makes suggestions for improvements where the existing practice is open to criticism. Many of the suggestions made apply equally to other coalfields.

ACCORDING to a writer in *Machinery*, it has been found that by leaving a pair of wheels standing on sand in tropical parts for a few weeks causes the portion in contact with the earth quickly to corrode, and this portion has caused flats on the tires within as little as a month of service. Removing the flats by turning means a loss of wearing surface, and after turning it has been found that the metal at the flat portion is spongy and flats will again occur. It has also been found that tires stored in a damp or dusty shed do not give the same service as tires of the same make fitted direct on the wheel centres by the makers. Tires should not be left in the open or exposed to the salinity and inclement weather found at most shipping ports, and if not directly put into use on arrival should be stored on rails in a dry place.

AT the recent Textile Machinery Exhibition held in Manchester, Markt and Co. (London), Ltd., exhibited a Veeder magnetic counter counting the drops of water falling from a tap into a vessel below. The water in the course of its fall completed an electrical circuit which energised a horseshoe magnet and thereby operated the counter. The mechanism which moves the number wheels in counting has two motions: one forward, which moves the counting wheel under the influence of the electro-magnet when the contact is made, and a return movement under the influence of a spring. Direct current is used, and for completing the electric circuit either the "wipe or sliding" or "make and break" contacts may be employed. The former has the advantage that ordinary material may be used as any corrosion caused by sparking tends to be worn away by the friction created.

ACCORDING to Professor A. P. Laurie, the most serious cause of weathering to-day of stone used for buildings, is the attack on the stone of the acid oxidised products of sulphur, and it is not confined to the towns. The action of the sulphur acids results in the formation in the case of limestones, and in the case of sandstones which contain calcite, of calcium sulphate, which is slightly soluble in water. The most serious effect of calcium sulphate is its crystallisation within the stone, resulting in the stone being mechanically broken up. Some sandstones are practically free from calcite, and these should be used in modern cities. Limestones differ considerably in susceptibility to attack and in tendency to break up, owing to the crystallisation of the sulphate of lime. Apparently one of the conditions is that there should be free and rapid evaporation from the stone after wetting, so as to draw the sulphate of lime to the surface and prevent it from crystallising inside the stone. This raises the question as to whether the hosing of buildings during hot weather would not be of advantage.

Miscellanea.

NEW rich deposits of radium-bearing ores are reported to have been discovered in the Belgian Congo.

IT is intended to start a foundry at the workshop at Harrow School as soon as funds can be obtained for the purpose.

TENDERS for the 1000 open low-sided 10-ton wagons required by the Egyptian State Railways should be in by January 21st next.

PLANS have been prepared by the Durham County Education Committee for the erection of an electrical laboratory at Jarrow secondary school.

A DEPOSIT of coal has been discovered about 60 miles from Sydney, containing three seams above 700ft. It is said to contain about 50 million tons of coal, which has very little sulphur.

IT is reported that a nitrogen-fixation factory is to be erected near Rastjepino, on the Moscow–Nijni Novogorod Railway. It is hoped to have the plant completed in twelve months time.

THE motor omnibus service between Manchouli, Manchuria, Urga and Sanpeitzefu has been started for both passenger and freight. The service is already stimulating business in these districts.

A COAL deposit has been discovered at Wangerhshan, north-east of the Summer Palace, or Wanshowshan, near Peking. It covers an area of at least 15 square li. The coal is reported to be anthracite.

THERE is a proposal on foot in India for the dredging of the river Saraswati, one of the big rivers of Bengal, flowing through the Hooghly district. The river was an important means of navigation 300 years ago, but is now almost silted up.

IT is reported that the construction of a beet sugar factory at Halesowen has been abandoned, on account of the lack of support on the part of farmers. On the other hand, it is proposed that a factory should be put up near Gainsborough.

THE Committee appointed by the South African Government to inquire into the question of State assistance for the shale oil industry has suggested a bounty ranging downwards from 5s. to 1s. in the pound, and has fixed the total amount of the bounty at a quarter of a million sterling.

THE Sydney plant of the British Empire Steel Corporation will be worked at full capacity throughout this winter up to February 1st, on orders recently booked with the Canadian National Railways. There are at present 2800 hands employed, with three blast-furnaces and twelve open-hearth furnaces working double shifts.

THE British Vice-Consul at Chemnitz informs the Department of Overseas Trade that the position in the machine-making industry in that district is apparently rapidly reaching a very critical state. There are few firms that did not reduce the number of their employees during October, and most of them have also gone on short time. The outlook for the next few months is far from being good and the almost general opinion is that the worst has yet to come.

HIS MAJESTY'S Consul at Stockholm, Mr. D. F. S. Filliter, reports that the proposal has been put forward for the formation of a company to supply electrical power to the island of Oland. The scheme is at present in its infancy. The proposal is that power should be taken from the hydro-electric power stations on the mainland—probably Sydsvenska Kraft, A/B, Malmö—and transmitted by a high-tension submarine cable to Oland and further distributed to the different parts of the island by low tension aerial cables.

SOME little time ago Pease and Partners, Ltd., prepared a scheme for the erection of a wharf on the river frontage of their Tees Bridge Ironworks, at Stockton, to be used in conjunction with their own steamers as a means of opening up continental trade. This scheme has now been completed and successfully launched, the first cargo of 500 tons of Cleveland pig iron having been landed at Hamburg. By means of the wharf, quick transport service is ensured, and costs are reduced; and the firm is of the opinion that in the near future continental trade will be developed as a result.

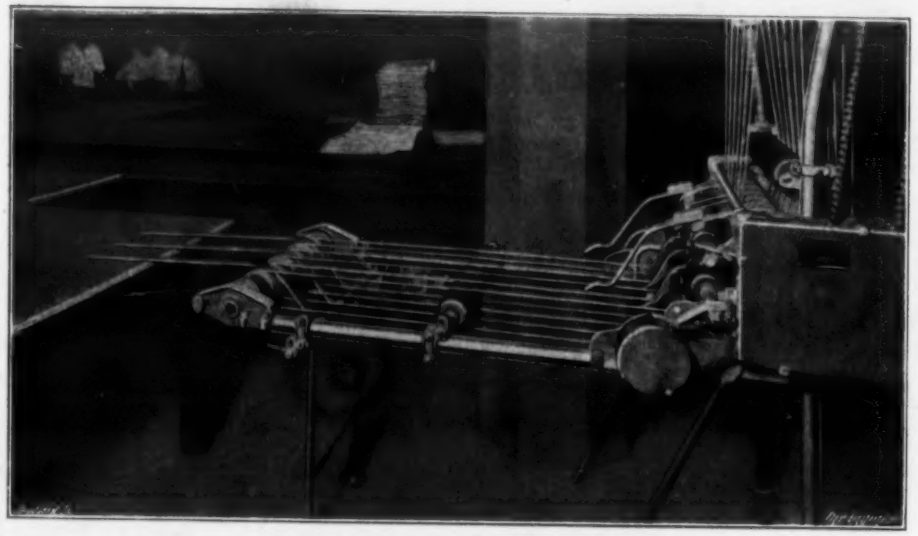
THE drill operating from the 800ft. level in the shaft on the Coronation Syndicate's farm Luipaardsvlei No. 10 has, according to the *South African Mining and Engineering Journal*, intersected at 173ft. the "Randfontein leader," 8in. wide, which, with "waste," showed 29 dwt. over 11in. Boring was continued, and it is now officially announced that the west reef has been struck at 273ft., carrying very high values. The upper portion (8in.) of this reef assays 3 oz. 12¼ dwt. per ton of 2000 lb., and the lower portion (9in.) assays 1 oz. 2 dwt. per ton, which is equal to 16 dwt. 4 gr. over 48in.

THE Sydney City Council is about to invite tenders for the plant required in connection with the proposed new power station. The estimated cost of the equipment is approximately £1,000,000. Pending the completion of the new station, a programme of work involving the arrangement underground of all high-tension mains in the city area is being pushed ahead. It is estimated that this work and the extension of the present reticulation system will involve an expenditure of about £2,500,000 by the year 1929. In this connection Mr. H. R. Forbes Mackay is visiting England to advise tenderers for the plant.

PERMISSION has been given by the United States Government, according to the *Canadian Engineer*, for the diversion by the Niagara Falls Power Company of an additional 225 cubic feet per second of water from the upper Niagara River. The new allotment will bring the diversion permitted to the company to 19,725ft. per second, just 25ft. less than the permitted total of 20,000. The additional water became available when the United States Power Board granted a licence to the Lockport and Burt Power interests to divert 275 cubic feet from the upper Niagara for the barge canal and Eighteen-Mile Creek at Lockport. With the 225 additional feet it will be possible to develop almost 5000 horse-power.

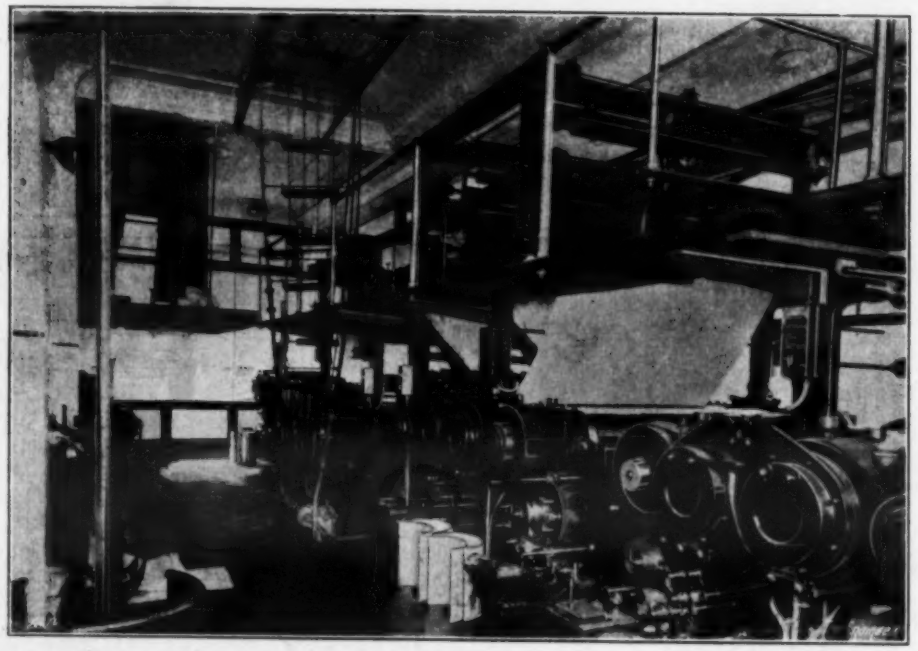
DISPATCH CONVEYORS IN AMERICAN NEWSPAPER OFFICES

(*For description see page* 619)



CONVEYOR WITH SPECIAL AUXILIARY GUIDES

PAPERS BEING DISCHARGED ON TO DELIVERY TABLE—DAYTON "EVENING NEWS"

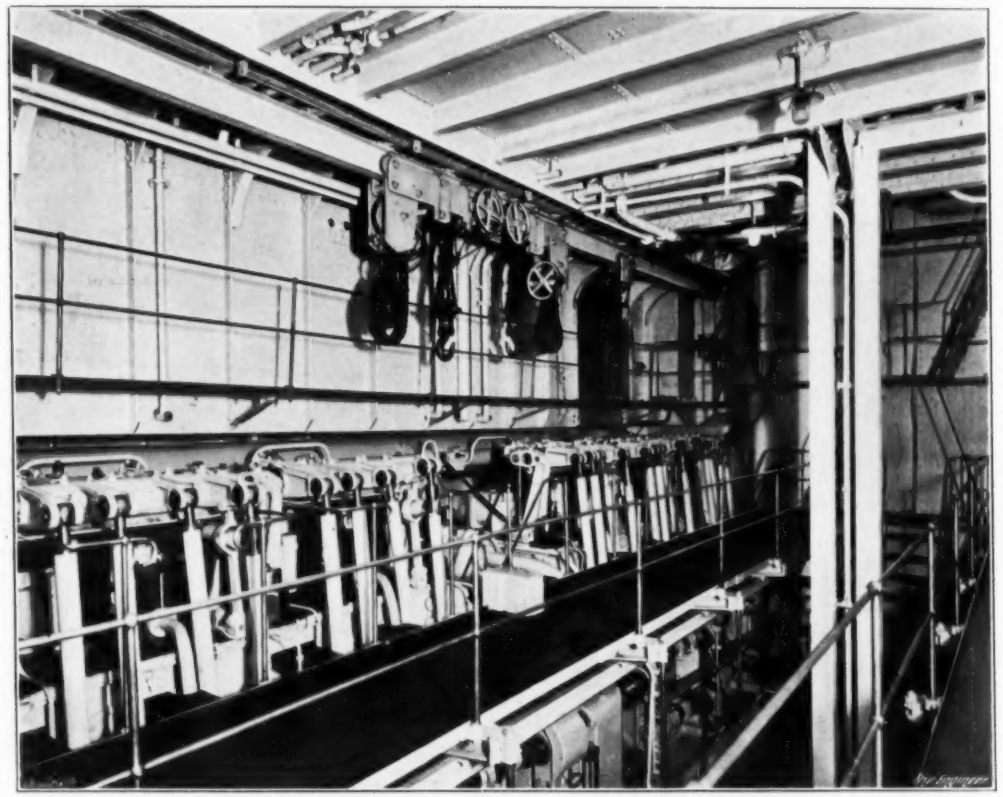


A PRESS ROOM SHOWING CONVEYOR, AND CONTROLLER ON PLATFORM

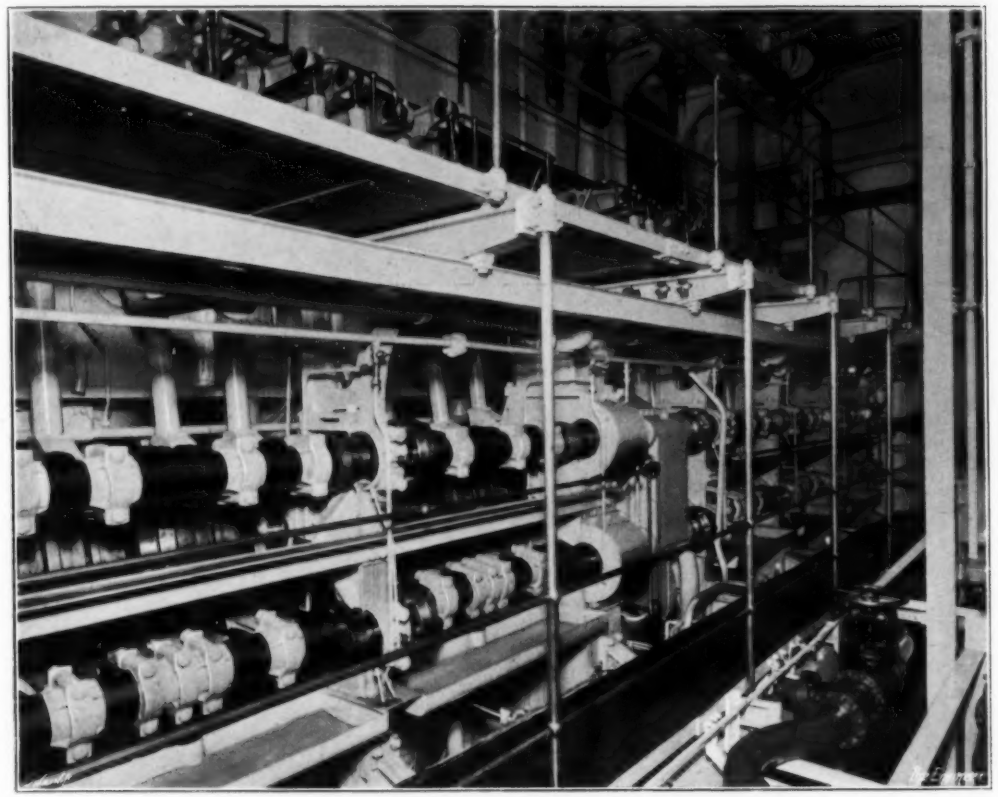
CONVEYORS IN THE "MINNEAPOLIS TRIBUNE" OFFICE

MOTOR LINER GRIPSHOLM—13,500 S.H.P. DOUBLE-ACTING FOUR-CYCLE MARINE OIL ENGINES

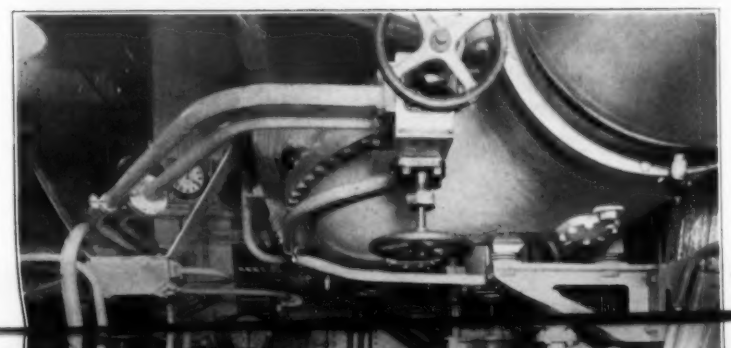
BURMEISTER AND WAIN, COPENHAGEN, ENGINEERS

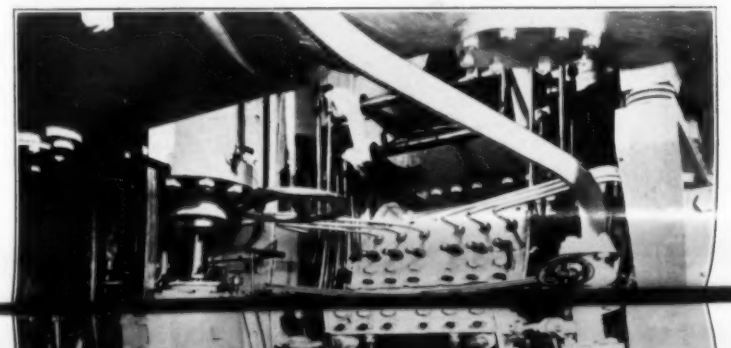


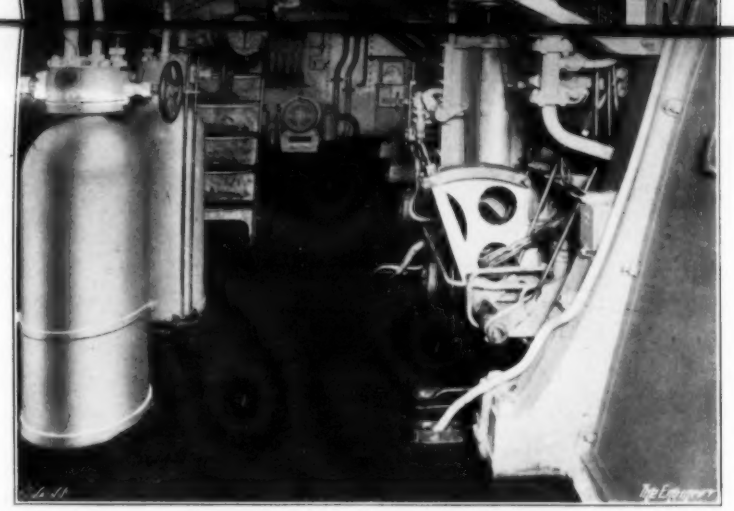
NO. I.—TOP PLATFORM IN MAIN ENGINE ROOM



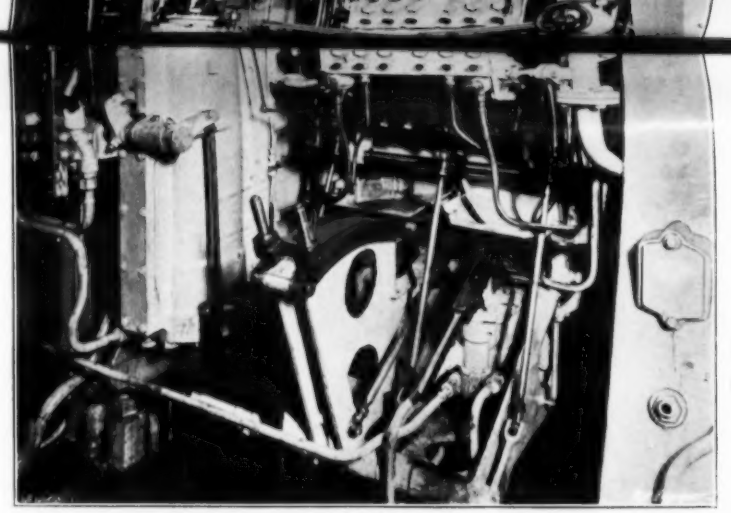
NO. II.—SECOND PLATFORM SHOWING CAMSHAFT AND REVERSING SHAFTS



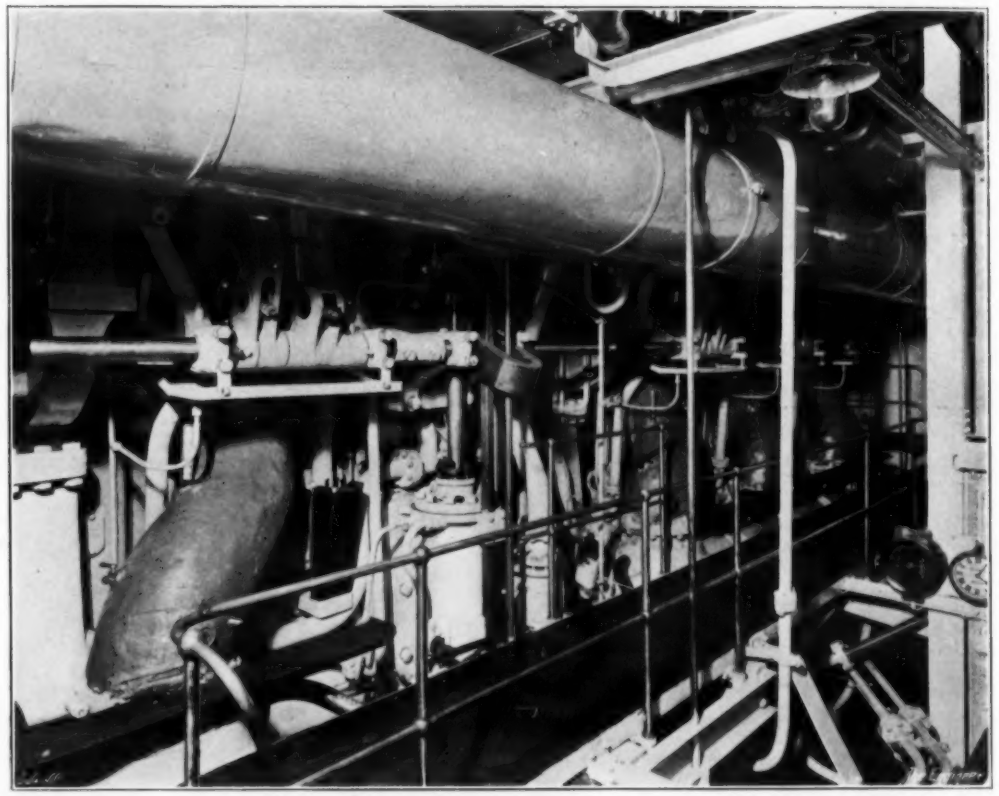




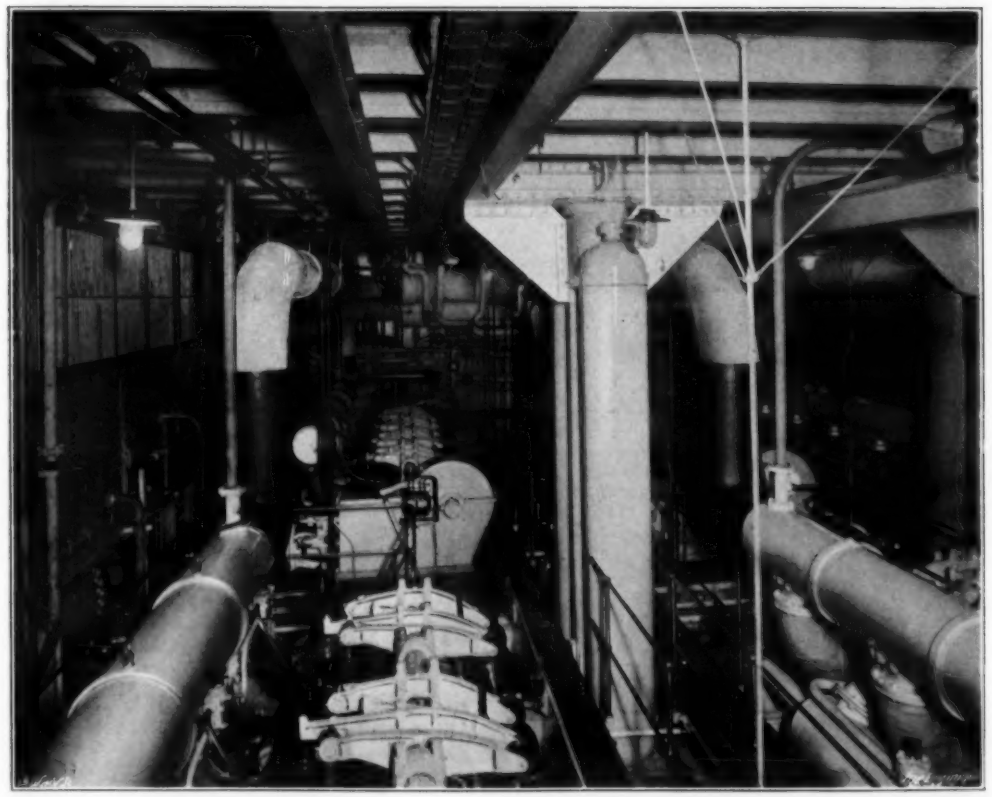
NO. III.—BOTTOM PLATFORM SHOWING MAIN CONTROLS



NO. IV.—VIEW OF FUEL PUMPS AND REVERSING GEAR



NO. V.—THIRD PLATFORM SHOWING BOTTOM VALVE GEAR



NO. VI.—VIEW LOOKING FORWARD IN AUXILIARY ENGINE ROOM

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*** With this week's number is issued as a Supplement a Two-page Plate illustrating the Double-acting Four-cycle Engines of the Motor Liner Gripsholm. Every number, as issued by the Publisher, contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

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TO CORRESPONDENTS

*** All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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TWO-PAGE SUPPLEMENT—MOTOR LINER GRIPSHOLM: 13,500 S.H.P. DOUBLE-ACTING FOUR-CYCLE MARINE OIL ENGINES.

ERRATUM.

On page 574 of our last issue, in the first column, six lines from the bottom, read "silicon" for "silver."

THE ENGINEER.

DECEMBER 4, 1925.

Stresses in Boilers.

So far as an exact knowledge of working stresses is concerned, there are few things more unsatisfactory than a boiler. It is true that we know with considerable accuracy the strength of plain cylindrical shells, whether subjected to internal or to external pressure. There is also little room for anxiety with regard to riveted joints or the strength of flat stayed surfaces. If a boiler could be considered as consisting of nothing more than a collection of such elements, the calculation of its strength as a whole would be a fairly simple matter. But this is very far from being the case. Boiler drums must have manholes and other orifices cut in them, and their stresses are further complicated by the constraint of the flat or dished ends. The latter are flanged to a small radius, are pierced for gauge connections and are frequently formed with flattened areas to receive the fittings. Even in the very simplest of boilers there are many places where the stresses caused by the working pressure are almost entirely a matter of conjecture. The freedom from accidents to which we are accustomed is due rather to the experience of generations of boilermakers than to what is wrongly called a "scientific" method of design. A boilermaker is working on truly scientific principles when he traces effects back to causes and modifies his practice when events indicate that a change is desirable. There are only two ways in which the mathematician can assist design—either by giving symbolical expression to facts already determined experimentally or by indicating what may be expected to occur with perfect materials of which all the properties are known. The most difficult practical problems are unfortunately rarely amenable to mathematical treatment, and even when they are, the mathematics may be as formidable as the problem itself.

The art of boilermaking can no more wait for mathematics than can any other branch of engineering, and whenever it is impossible to calculate stresses in advance the only thing to do is to deduce them afterwards from the behaviour of the material. It is not necessary that a boiler should burst, or even that it should be permanently deformed, for the stresses to which it is subjected to become evident. Internal pressure will cause minute extensions, contractions or deformations of the shell as the latter endeavours to assume a shape in which its cubical capacity will be greater. So long as the elastic limit of the material is not exceeded these strains will be harmless and temporary, the shell returning to its original size and shape when the pressure is relieved. Within this elastic range, of course, the stresses will be exactly proportional to the strains produced by them, so that knowing the strains the stresses can be determined. In bridge work, and especially where redundant members are concerned, the directness of this method has appealed to engineers for some time, and various instruments have been devised to enable the requisite measurements to be taken. The more difficult problem of determining the stresses at various points of a boiler shell by means of a measurement of the strains has been attacked with characteristic ingenuity by Mr. C. E. Stromeyer, who gives the results of numerous experiments in his annual memorandum to the Manchester Steam Users' Association. The method he has devised for measuring the strains is delightfully simple after the assemblies of microscopes, mirrors and what not which one has come to associate with small strain measurements. At the points, usually an inch or two apart, between which the strain is to be measured the ends of two stout wires are electrically welded. These wires project normally from the plate and carry at their outer ends adjustable gramophone needles. The needles are arranged parallel to each other and at right angles to the wires. On passing a piece of smoked glass across the needle points two parallel lines are drawn. Any deflection of the boiler shell between the wires will cause the needles to recede from or approach each other, the alteration of the distance between the lines owing to the relative movement of the needles being a greatly magnified measure of the deflection of the plate. Using wires 12in. long, spaced 1in. apart, results which are correct to within less than 1 per cent. are said to be obtainable. For details of the various tests carried out and the results obtained reference should be made to the memorandum itself, which we shall reprint in a future issue. A number of measurements of the deflection of the corners of the fire-box and fire-box casing of a small locomotive type of boiler appeared to show that the strength of the corners was not equal to that of the flat stayed surfaces. This result is considered confirmatory of the experience that cracked corners are not infrequent. Mr. Stromeyer, however, seems hardly prepared to recommend a remedy. If the stays were placed further from the corners and the latter increased in radius matters might be improved, as he points out; but he seems very undecided as to whether either thickening or thinning the plates would be beneficial. In favour of thinner plates he refers to the fact that the stresses at one corner of the casing where the plates were doubled were apparently over three times as great as at another corner where there was only a single thickness of metal. This result, we think, ought to be verified by further experiments. It not only seems unlikely that doubling the plate would raise the stresses under test pressure from 10,120 lb. to 33,400 lb. per square inch—the latter being dangerously near the yield point of the material—but if increases of stress of this order actually occur experience should show their effect. Surely if one corner was really stressed three times as heavily as any of the others, such corners would suffer a sufficiently great disproportion of failures in service to call attention to the severity of the conditions. Another somewhat unexpected effect appears in the case of a small vertical donkey boiler. The movements of a row of twelve scribing wires standing on a radial line across the top of the boiler indicated that the central uptake, instead of acting as a tie rod holding the dished top plate down, was really behaving as a strut when the boiler was under pressure. The explanation suggested by Mr. Stromeyer is that the horizontal stretching of the boiler shell and the horizontal contraction of the fire-box would both tend to diminish the distance from the fire-box crown to the boiler top, thus throwing the uptake into compression. Such a result might hardly have been anticipated, but the evidence of the scribers seems conclusive, at any rate so far as the particular boiler in question is concerned.

It was the reported tendency of certain locomotive fire-boxes to crack at their corners which caused Mr. Stromeyer to embark on the series of investigations referred to. He was no doubt also stimulated by the serious explosions which have recently occurred on the Continent owing to the cracking of dished ends. In both cases we have the concentration of the stresses due to the "breathing" of the boiler along a narrow band of metal bent to a comparatively short radius. The method

he has devised appears to provide a practical means of estimating the magnitude of the stresses which will occur in any particular kind of corner. It is equally applicable to the determination of the stresses which are produced at a joint in the plates. With riveted boiler drums now in service under a pressure of 700 lb. and more to the square inch the fullest possible knowledge of the stresses involved is desirable. The responsibility of boiler-makers is increasing every day. It does not end with proper design, for the best design in the world is useless without proper material properly treated. A particularly bad explosion was caused in this country several years ago by the cracking of the corner of a dished end plate of a boiler drum. The design was adequate in every way, but examination of the wreckage showed that the metal of the end plate had been dented all round inside the radius of the flange by the action of the riveting machine. The possible embrittlement of boiler plates by highly alkaline water, especially with modern steam pressures and temperatures, is another source of danger, which, like grooving, is likely to be increased by concentration of stress. It is a truism to say that the most dangerous parts of a boiler are the most highly stressed parts, but it serves to call attention to the need for exact knowledge of where and how great the maximum stresses are.

Electricity Supply.

THE proposals which the Government is about to put forward relative to electricity supply are no longer secret. Speaking at the recent annual "Beama" dinner, Lord Weir threw considerable light on the contents of the long-promised report which will apparently be issued before Christmas. Briefly, it will advocate the generation of electricity from waste heat and the establishment of an open market for it, or, in other words, the provision of a network of mains from which the electricity so generated can be drawn; the development of large existing undertakings; legislative facilities for the construction of transmission lines, and the standardisation of frequency. Assuming that Lord Weir outlined the Government's proposals in full, it will be seen that the report will contain nothing new or revolutionary, for all these questions have been previously discussed, although little progress has been made in the direction of putting them into practice. That waste heat can be utilised advantageously for generating electricity there is not much doubt, and that by its help cheap current could be supplied in cases where it is unnecessary to transmit the current long distances is not questioned. The removal of the obstacles which are met with in connection with the erection of transmission lines in this country is a matter of no small importance. The need for relief as regards wayleaves and regulations controlling such lines has long been recognised by those engaged in the electricity supply business. When the report is published light will no doubt be thrown upon the manner in which the much-discussed task of standardising frequency will be accomplished. The fifth annual report of the Electricity Commissioners just issued states that Messrs. Merz and McLellan were engaged to investigate and report upon the financial and practical aspect of a scheme of complete standardisation, and a suggested programme has been prepared, showing in detail how the change-over might be effected in a large non-standard area. As we have said on previous occasions, it would undoubtedly be a good thing if all odd frequencies could be eliminated, the only question to be settled being whether the large sum of money which the change would involve could not be more profitably spent.

Members of the "Beama" were obviously delighted with Lord Weir's statement that it was the Government's intention to standardise frequency, for the simple reason that it will entail a very considerable amount of work. There will be big orders for generators, motors, transformers, converters, and meters designed to operate at 50 cycles per second; but when the work is completed there will still be two distinct kinds of currents, for the direct-current networks will remain. It is to be hoped that if State aid is to be given to the electrical supply industry it will be applied judiciously and that colossal sums of money will not be spent on frequency standardisation if it can be shown that the money might be devoted to a more useful purpose. From the Electricity Commissioners' fifth annual report, to which we have just alluded, we note that during the year covered further progress was achieved in the direction of the elimination of various odd frequencies, and alterations were also made from direct-current to alternating-current distribution. Changes of the latter kind seem to us to be highly desirable; in fact, we are tempted to ask whether the Government should not help to finance such changes. What seems to be largely at the back of this desire to standardise frequency is the inter-connection of stations. Stations working at different frequencies cannot, of course, be interconnected without the employment of frequency changers, which are utilised on a fairly extensive scale in America. We have no desire to see these machines installed in large numbers in this country, where there is already far too much plant of a similar nature and where a wholesale system of interconnection of distant stations would appear to have little to recommend it. The whole question obviously demands most careful consideration. High-pressure direct-current transmission should not be completely ignored. For general transmission purposes, however, there is nothing which can compare at present with the high-pressure three-phase system, which, in our opinion, will continue to hold its own, although it is not improbable that in certain cases it will, in due course, sometimes be found desirable to couple two stations together by means of a high-pressure direct-current line, provided the line merely serves as an interconnector. Some well-known American engineers appear to be engaged upon this high-pressure direct-current transmission problem, and great things are expected of the high-power thermionic valve, which, according to some authorities, will one of these days not only be used for rectifying high-pressure alternating current, but also for producing alternating current at any desired frequency when fed with direct current. By means of the oscillating valve the transformation of frequency may eventually become a relatively simple process, although at present the large high-pressure valve is, it seems, rather far removed from the field of heavy electrical engineering. The problem to be settled at the moment is whether a standard frequency would prove a real benefit to the consumers of electricity or whether the supply cannot be given at two or three frequencies with practically the same satisfaction. An anomaly resulting from the present stage of development of electricity supply in Great Britain, states the Electricity Commissioners' fifth annual report, is revealed by the fact that, although it has been the consistent endeavour of the Commissioners since 1920 to bring about the supersession of small-scale generation in a multiplicity of stations, they have nevertheless found themselves in the position of no alternative but to sanction the establishment of further small generating stations in various parts of the country. The provision of such stations has proved to be the only method of meeting, for some years to come, the demand for electricity which has been shown to exist in a number of rural and other isolated areas, and in the exercise of their duty of promoting the supply of electricity the Commissioners have felt constrained from taking a course of action which would have debarred the initiation of local development for an indefinite period, pending the establishment of comprehensive transmission and distribution systems from which bulk supplies could be made available over wider areas than hitherto. The question in which many are interested, however, is "how much better off will the consumers in those rural and other isolated parts be when a standard frequency has been adopted and when these bulk supplies have been established?" While we firmly believe in 50-cycle current for all purposes—industrial, domestic and traction—it remains to be proved whether it is now expedient to scrap a considerable amount of good and useful plant in order that in future only one kind of current may be generated.

Perhaps a more reasonable policy than that which the Government is now about to put forward is the one set forth in the Coal Conservation Committee's Report of 1918. The main transmission system, this report says, must be alternating current three-phase at a high voltage—no engineer would dispute it—but a more difficult question is that of frequency, for in Great Britain no less than ten frequencies are employed to-day. An analysis of the situation as regards frequency, the report continues, has been made. A division of England and Scotland into areas having frequencies of 50, 40, and 25 cycles respectively represents the least amount of scrapping of existing plant consistent with development on right lines. Roughly speaking, England, south of a line between the Humber and Carlisle, could be run at 50 cycles, with the exception possibly of the Black Country; between this line and the Cheviots supply might remain at 40 cycles, while the whole of Scotland could be standardised at 25 cycles. This report is signed by a number of eminent men, including Mr. Charles H. Merz, yet it has apparently now been decided that success in the electricity supply business can only be achieved by the adoption of a single frequency, regardless of the fact that it would mean scrapping a large amount of good and useful plant. No doubt, however, the matter will be taken up by many central station people when the report appears, and it is not improbable, we think, that the Government's proposals will ultimately be modified.

Obituary.

H. W. MORLEY.

WE hear with great regret of the death, on November 19th, in a nursing home, of Mr. H. W. Morley—a mechanical engineer of the first water. Mr. Morley served his time with Kitson and Co., Ltd., of Leeds, and subsequently took an engineering course at Bradford Technical College. He then worked with Mr. Wilson Hartnell for a time, and also with Hick, Hargreaves and Co., Ltd., of Bolton. In 1890, when still quite a young man, he became proprietor of Cole, Marchent and Co.'s works at Bradford, and changed the name of the firm to Cole, Marchent and Morley, Ltd. There he wrestled with difficulties and overcame them. The works and the machines were too small for a good deal of the engines he undertook to build, but he was not to be beaten by obstacles of that kind, and devised ingenious means of surmounting them. A tour round his shops with Mr. Morley himself was an education in mechanical engineering, for he had studied with care all sorts of problems of design and manufacture, and loved to talk about them. He developed the drop piston valve type of steam engine, and invented an ingenious piston valve with restrained rings. As the pistons had to drop quite freely and yet be steam-tight, the slightest distortion of the liners either by heat changes or mechanical means had to be prevented, and Mr. Morley went into the problem with his customary thoroughness and sound mechanical genius. In 1912 the firm took up the manufacture of Diesel engines, and again Mr. Morley found fascinating problems to tackle. His health, however, had become indifferent, and in 1913 he retired from active work but carried on a consulting practice for a few firms and mills in the Bradford area. He was a member of the Institution of Mechanical Engineers, and one of the founders of the Bradford Engineering Society. He did much to help and encourage the public engineering of Bradford, for he brought to all engineering subjects sound common sense combined with a profound knowledge of his craft.

JOHN HENRY WIDDOWSON.

BY the death of John Henry Widdowson, in his sixty-ninth year, a very familiar personality in the engineering circles in Manchester has been removed. Mr. Widdowson had been in failing health for some considerable time. He served his apprenticeship at the works of Joseph—later Sir Joseph—Whitworth, where his father held a prominent position, and in 1876 the two Widdowsons started business on their own account as makers of screwing tackle, taps and dies. The practical experience and business-like aptitude which Mr. Widdowson, sen., and his son, had acquired enabled them to build up a very large connection as makers of that class of goods, and their name was famous amongst engineers all over the civilised world. The subject of this memoir was noted for his warm-hearted generosity and kindliness of manner, and his cheery presence will be greatly missed by a very wide circle of friends. He was a member of the Institution of Mechanical Engineers, the Iron and Steel Institute, the Institute of Metals, and the Manchester Association of Engineers, and was on the Council of the last-named institution for some time.

SIXTY YEARS AGO.

IN a leading article in our issue of December 1st, 1865, we discussed the circumstances of an accident to a cupola fan at the Blast-lane Ironworks of Davy Brothers, Sheffield. The fan, one of Platt and Schiele's "silent" type, was running at 1020 revolutions per minute when it suddenly flew to pieces. Mr. Davy, senior partner of the firm, received injuries from which he died soon afterwards, and a workman who was also standing close to the fan at the time was gravely hurt. At the inquest little information was elicited as to the probable cause of the accident. In attempting to probe the matter we wrote, we said, with the more unction from the circumstance that a few years previously we ourselves had narrowly escaped Mr. Davy's fate, although the fan involved was of a different make. We were not disposed to believe that the fan disc burst under excessive centrifugal force, for the disc was not broken to anything like the same extent as the external casing. One of the brackets supporting the fan shaft, we

were inclined to argue, gave way and caused the disc to strike the casing and smash it into fragments. The fan disc and its shaft were of cast iron and formed in one piece. We did not agree with the practice of using cast iron shafts, but we had to admit that whatever the shaft had been made of the results attending the failure of the bearing would have been the same. It is curious to read that the makers of the fan had recently substituted in their later fans steel for cast iron shafts, although steel was regarded as a very uncertain material. They also advocated a reduction of the prevalent high speeds of fans by using two low-speed fans in series. . . . In these days when the six dot seconds are received from Greenwich all over the land by the aid of wireless broadcasting it is interesting to discover in the issue of this journal referred to above some account of the means employed at the famous Observatory sixty years ago for the broadcasting of time signals. A large brass barrel driven by clockwork to rotate once in two minutes was ruled with lines and seconds dots, and with it contact was made by a pricker operated by an observer at a transit instrument. The time signal was thereupon transmitted to Mr. Varley's chronograph in the International Telegraph Company's offices near the Bank and thence sent automatically to all parts of the kingdom. In some northern towns the signal was arranged to fire time guns. The transit instrument erected in 1847 was, it may be noted, designed by the Astronomer-Royal, Professor G. B. Airey, the engineering work being undertaken by Mr. May, of Ransomes and May, afterwards Ransomes and Sims, and the object glass being ground by Mr. Sims, the optician.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HEATLESS COMBUSTION.

SIR,—May I first summarise the course of the argument between Mr. Pochobradsky and myself? In his first letter he sought to show by thermodynamic analysis that the calorific value of a fuel may depend upon temperature. Taking calorific value to mean heat of reaction, I immediately questioned the possibility of any analysis accomplishing such a proof. Unfortunately, a misinterpretation of his method of analysis arose owing to the inadequacy of his postulation of the conditions appertaining thereto. In my second letter I acknowledged the misinterpretation, but still held to my fundamental point that thermodynamic analysis cannot show heat of reaction to depend upon temperature. Mr. Pochobradsky's calorific value is not the heat of reaction, as he admits. I then indicated that the variation in his calorific value was the quantity which modern engineering thermodynamic analysis includes as an effect upon internal energy, a quantity dependent solely upon temperature. In his third letter, however, Mr. Pochobradsky makes much of the misinterpretation, and he is entitled to whatever comfort he can derive from that; but in attempting to make me out a blunderer, he has rendered, as I shall show, the fallacy of his position abundantly clear.

In the first place, taking the points in his letter in due order, I did not accuse him of misinterpretation of Planck, but merely indicated a vital omission in his statement of an equation used by Planck. By postulating conditions such that the heat of combustion is discharged through the combustion chamber at a rate sufficient to ensure constancy of temperature throughout the combustion process, the choice of the terms "same temperature" and "constant temperature" becomes purely a matter of taste.

The treatises on thermodynamics by Zeuner and Ewing, for example, both give the definition of internal energy which I follow, while Mr. Pochobradsky follows Planck's definition. Such definitions, however, can make no difference to any results which may be deduced from the machinery of thermodynamic analysis. The transference of the heat of reaction from the Q to the U term is a procedure justified only by its convenience in the analytical expression of the heat discharged through the walls of the combustion chamber after the final temperature of the products has fallen to the initial temperature of the mixture, or, what is the same thing, of the heat discharged during isothermal combustion.

The reason for the stated reversal of Mr. Pochobradsky's curves lay, of course, in the reversal of sign which had to be introduced to interpret his equations according to the definition of U to which I adhere. That I gave no analytical results arose merely because I saw no purpose, and see none still, to be gained in carrying out the analysis.

My example of a gas mixture compressed adiabatically to the critical temperature, fired and re-expanded adiabatically, then takes up the bulk of Mr. Pochobradsky's attention. As I anticipated, he has found it difficult to solve, but in attempting to circumvent it he has now placed himself in what appears to me to be a somewhat vulnerable position. In refuting my purely verbal proof that such an example shows the term "heatless combustion" as defined by him to be a misnomer, I shall show that he first gives a wrong analytical statement of my definition of calorific value as the heat of reaction and then uses this to prove that no net work is done in the case I submitted. This is accomplished, it may be noted, after saying that he is "unable to say what the compression and expansion would be."

My definition of calorific value is not expressed analytically by

$$Q = U_p^{t_2} - U_p^{t_1},$$

but by

$$Q = U_p^{t_2} - U_m^{t_1}.$$

The former does not express the heat of reaction while the latter does. Mr. Pochobradsky, however, inserts the former in his equation (6) and so deduces the result he desires, namely, that no net work results by compression and expansion. In other words, he gives my definition of calorific value a wrong analytical statement, which he then introduces into thermodynamic analysis to prove himself right.

Then again he says that gaseous mixtures and combustion products fulfilling my assumption of the constancy of R, the gas constant, are unknown to him. The combustion of methane in air provides an actual example.

However, Mr. Pochobradsky says I have given no analysis, so, seeing he cannot comprehend the identity of thermochemical and engineering thermodynamics, I shall try to convince him of such identity.

His calorific value has for analytical statement, as given by himself,

$$Q = M_m \int_0^{T_1} C_{vm}\, dT - M_p \int_0^{T_2} C_{vp}\, dT + K_m - K_p \quad \cdots\cdots (1)$$

where $K_m - K_p$, for complete combustion, represents heat of reaction. This heat of reaction, which, as I understand it, is the true calorific value, is

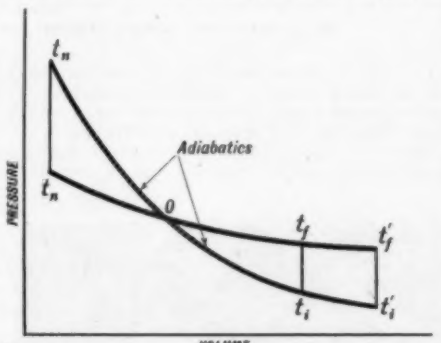
$$K = K_m - K_p = M_p \int_0^{T_2} C_{vp}\, dT - M_m \int_0^{T_1} C_{vm}\, dT \quad \cdots\cdots (2)$$

Combining (1) and (2) gives $Q = M_p \int_{T_1}^{T_2} C_{vp}\, dT \quad \cdots\cdots\cdots (3)$

as another expression for Mr. Pochobradsky's calorific value. No analysis is really required to show this, for his calorific value is the heat given out during cooling of the products from the temperature T_2 to T_1. In other words, his calorific value curve against temperature is nothing but the internal energy curve of the products of combustion against temperature, meaning by internal energy, not Planck's definition of that quantity, but the definition given in treatises such as that of Ewing.

I shall now show that Mr. Pochobradsky's final deduction that "compressing the mixture adiabatically to the neutral point, causing combustion (heatless) to take place at that point and re-expanding to the original volume there will be no surplus of work and the products of combustion will have the same temperature as if compression and expansion had not taken place at all and the combustion had been performed at the original volume," is self-contradictory.

In Fig. 1 t_i represents the initial temperature and point on a P V diagram at which constant volume combustion takes place to temperature t_f. If, however, the mixture is first compressed adiabatically to the neutral temperature t_n and combustion then initiated, the temperature will be unaltered, but the pressure will depend upon the value of R. Taking, from my point of view, the most unfavourable case that the pressure falls to the lower t_n point, then, according to Mr. Pochobradsky, the adiabatic expansion line must pass through t_f, and no net work results. The area t_n o t_n must therefore be equal to the area t_i o t_f. This equality, however, cannot hold for all values of t_i, for if we take the initial condition at t_i, the adiabatics and the t_n line will remain unaltered so that t'_f represents the final temperature of constant volume combustion from t'_i. If it does not then the adiabatic does not pass through t'_f. Assuming, therefore, that, according to Mr. Pochobradsky, the adiabatic expansion line passes through t'_f, then area t_n o t_n can be no longer equal to t'_i o t'_f, and there will be a balance of work in hand. In other words, if Mr. Pochobradsky's proposition holds under one set of initial conditions, it can hold under no other set. To give equality of work area under all conditions the two adiabatics must coincide, and that would immediately destroy the other part of his proposition that the expansion adiabatic must pass through the t_f points.



"THE ENGINEER" SWAIN &c.

Also, engineers will be surprised to learn that all engines compressing adiabatically from the same initial conditions, burning fuel at constant volume, expanding adiabatically, and rejecting heat at constant volume down to the initial temperature, *i.e.*, all ideal gas and petrol engines, should have the same efficiency irrespective of compression ratio. For, in all cases, the efficiency is

$$\eta_t = \frac{\text{Heat received} - \text{Heat rejected}}{\text{Heat received}},$$

and the heat rejected, *i.e.*, the heat given up during cooling at constant volume, must in every case, according to Mr. Pochobradsky's deduction, as quoted, be given by Q, his calorific value. Also, the heat received is the true calorific value K and is constant. Therefore

$$\eta_t = \frac{K - Q}{K} = 1 - \frac{Q}{K}$$

But since the initial conditions are the same in every case, then Q is constant and η_t = constant.

From the foregoing demonstrations it would appear that Mr. Pochobradsky has become involved in a morass of thermodynamic contradictions from which he will find it difficult to extricate himself.

WM. J. WALKER.

Dundee, November 23rd.

LOW TEMPERATURE CARBONISATION.

SIR,—With regard to your recent editorial on this subject, and in view of certain recent happenings and the urgent importance of more scientific and economical methods for the use of coal in Great Britain, I suggest that it is high time there was formed an Institution or Association of Fuel Technology and Low Temperature Carbonisation, and that a preliminary conference be held in London of the very large number of people interested in the matter.

The general public, including engineers and chemists, have been hoodwinked long enough over this question of the proper utilisation of our valuable coal resources, especially the home production of oils and also of free-burning smokeless fuel, and after all our pioneer work we are now in danger of being left behind by the remarkable advances in Germany on the subject, which are in many cases equally applicable to bituminous coal as to the German brown coals.

I have myself the details of over 120 processes for the scientific treatment of raw fuel, and few people realise the amazing amount of work that has been done on this matter in Great Britain, the United States, Canada, Germany, France, Holland, Scandinavia, Austria and Japan, while important investigations are now to commence in Spain, Chili and Russia, the Soviet Government having established an important thermo-technical institute in Moscow.

In Germany, for example, we have now the "Fellner-Ziegler," "Thyssen" and "Kohlenscheidungs Gesellschaft" processes, all of which have had long-continued and large-scale experience. In addition to these, of the greatest interest are the "Delkeskamp," "Raffloer," "Dobbelstein," and the "Meguin" processes, besides the work of Julius Pintsch, of Berlin, and the very valuable investigations in connection with the utilisation of brown coal, particularly by Seidenschnur, Lurgi A.G., "Limburg," "Kohlenveredulungs A.G.," "Streppel," and the "Deutsche Erdoel A.G." Then again, there are the processes of epoch-making importance, with which everybody is familiar, such as the work of Bergius in connection with hydrogenation, and the "Synthol" method.

The day for burning valuable raw coal as mere fuel is passing fast, and the hundreds of influential people in Great Britain interested, whether technically or otherwise, should unite together without any further delay, especially as our country with its rich bituminous coal, relatively small distances of travel, and open fires is the most suitable in the world for the application of such methods.

DAVID BROWNLIE.

London, November 30th.

COMPOUND LOCOMOTIVES.

SIR,—*Apropos* of the Lima Works' locomotive, the *Railway Mechanical Engineer*, New York, published the complete results, with graphs, of the road tests of this 0–6000–0o simple engine, working at 240 lb. pressure, in its October issue. In the November issue, under the head of "What Our Readers Think," a correspondent points out that, although it "possessed but few of the fuel-saving refinements which are now found so essential, the Michigan Central Railroad two-cylinder saturated steam cross-compound, Class W, No. 585, need not fear comparison with to-day's best machines on an efficiency basis."

He quotes as follows from tests on the Pennsylvania Railroad laboratory plant:—

	Maximum.	Minimum.
Dry coal per d.b.h.p. hr., lb.	3·61	2·14
Boiler efficiency, per cent.	78·42	48·81
Machine efficiency, per cent.	94·16	74·98
Locomotive efficiency	8·04	4·80

These bench tests gave from 19·78 lb. saturated steam, with 45 per cent. cut-off, up to a maximum of 24·61 lb.—62 per cent. cut-off—per indicated horse-power hour. But a road test must not be compared with a bench test except by taking about 20 per cent. to 30 per cent. off the road figures. In the Lima locomotive, the auxiliaries, &c., take about 20 per cent. of the steam, so that, with this deduction, the net superheated steam consumption is as low as 19·09 lb. per indicated horse-power hour with 48·5 per cent. cut-off; the total average being 20·16 lb., without the auxiliaries. The Michigan Central cross-compound averages about 20·3 lb. net saturated steam per indicated horse-power hour with cut-offs of 45 per cent.

On the same plant the Hannover compound class 8-8 consumed from 16·59 lb. (minimum) to 21·29 lb. (maximum)—average 18·59 lb.—dry steam per indicated horse-power hour.

On the whole, this correspondence of the *Railway Mechanical Engineer* may perhaps be right in questioning the immense increases in American locomotive efficiency during the past decade or so.

The chief interesting fact brought out by the Lima locomotive tests is that the highest thermal efficiency of 5·99 per cent. was realised with an average cut-off of 45 per cent.; while the shortest average cut off of 35·2 per cent. coincided with only a medium efficiency of 5·07 per cent., proving that long cut-offs give the best economy.

R. C.

SIR,—Your correspondent "R. C." appears to be convinced that compounding cannot be improved by superheating.

The experiments carried out on the Midland Railway indicated that a considerable advantage accrued from employing the two features in conjunction. Tests made between two of the three-cylinder 7ft. compounds, one with and the other without a superheater, showed that the superheated engine was more economical than its saturated steam competitor to the extent of 25·9 per cent. in coal and 22·3 per cent. in water consumption. The inference is that the increase in the volume of the steam which results from superheating (without loss of pressure other than that due to the passing of the steam through the superheater elements) is even more important than the reduction in the temperature range.

F. W. BREWER.

Stevenage, Herts., November 30th.

SIR,—Please allow me to express my thanks and appreciation to "R. C." for his masterly exposition of the position and capabilities of the compound locomotive on the Continent. Their efficiency is remarkable, and with a steam consumption some 47 per cent. lower than our own supposed best must make our designers feel very uncomfortable for the present, at any rate. No reader of THE ENGINEER can now say that he does not know what is being actually accomplished every day.

COMPOUND.

November 25th.

THE STATUS OF NAVAL ENGINEERS.

SIR,—As an old naval engineer may I say how much I appreciate your leading article on the question of "The Status of Naval Engineers." It was timely, and I hope will be effective in drawing attention to this important matter. To meddle with engineering *personnel* matters seems to have the same attraction for some naval executive officers as a candle has for a moth. They cannot keep away from it.

The Admiralty Fleet Order you refer to affects most gravely some 250 officers, who by all sorts of promises and encouragements have specialised in engineering, and, of course, it also affects the officers under training in Keyham College. From all accounts the officers themselves and the parents of the midshipmen are up in arms as they have a perfect right to be.

In a sense the action of the Admiralty is a challenge to the engineering profession, and as such it should be taken up immediately by our great engineering institutions. It is often remarked that engineers do not take the part in public affairs they should do, but this is a case where their concerted action might be of the greatest value.

The Institutions have ample means of studying the position and the knowledge and experience for formulating a plan of action, and they would confer an inestimable boon on the Navy if they could get the engineering *personnel* question once and for all settled on a firm and satisfactory basis acceptable to all concerned.

M. I. MECH. E.

The Swedish-American Motor Liner Gripsholm.

No. II.*

THE twin-screw motor liner Gripsholm is propelled by double-acting four-stroke cycle marine oil engines manufactured by Burmeister and Wain, of Copenhagen, but the whole of the installation work and the pipe work was carried out by the marine engine department of the builders of the ship, Sir W. G. Armstrong, Whitworth and Co., Ltd. The accompanying drawings, Figs. 4 and 5, show in elevation and plan respectively the arrangement of the machinery on the ship. It will be seen that there are two engine-rooms. The main engine-room, which is 48ft. 2in. in length, is placed aft of 'midships and forward of it is the auxiliary engine-room, with an overall length of 62ft. 4in. In a recess which is forward of the two engine-rooms there are the two oil-fired boilers which supply steam for the thermo-tank heating system and the fresh water distillers. In the main engine-room itself are installed the two propelling motors, while in the wings are placed the oil settling tanks and also such auxiliary pumps as are required to supply the main engines with fuel oil, lubricating oil, and cylinder cooling water. The present article will be restricted to a description of the machinery referred to, and illustrations Nos. I. to V. in to-day's Supplement give some typical views in the engine-room, whilst Fig. 1 below shows the pumps mentioned at the after end of the main engine-room. Illustration No. VI. in the Supplement is a view of the auxiliary engine-room, the machinery of which we shall deal more especially in our following article.

The engine-room arrangement which we have outlined is one which would seem to have many advantages for liner work. It enables good use to be made of the space at the centre of the ship which is unsuited for passenger accommodation on account of its very limited height, and is equally ineffective as cargo space on account of its distance from the main cargo hatches. Such an arrangement does, however, give a divided duty for the engineering staff, as the engineers in the after engine-room supervise the running of the main engines, whilst the duties of the staff in the forward engine-room are those of keeping the main engines supplied with compressed air for running and manœuvring and electric power and light, also steam for service in the ship.

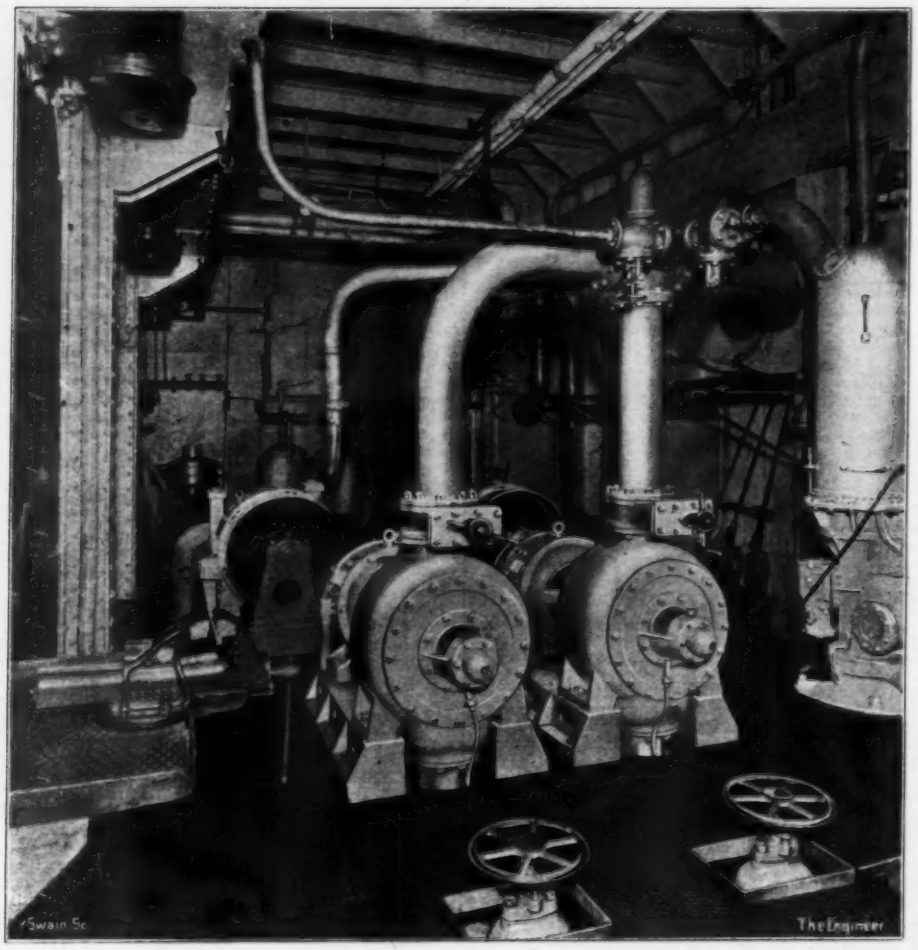


FIG. 1—COOLING WATER AND LUBRICATING OIL PUMPS IN MAIN ENGINE ROOM

THE MAIN ENGINES.

The Gripsholm is propelled by two sets of double-acting four-stroke cycle marine oil engines of the Burmeister and Wain type, designed for a total output of 16,300 indicated or 13,500 shaft horse-power when running at a normal speed of 125 revolutions per minute. Each engine has six cylinders, each with a bore of 840 mm., or $33^1/_{16}$in., and a stroke of 1500 mm., or $59^1/_{16}$in. Fig. 3 gives a view of one of the engines taken on the test bed, and the drawing Fig. 4, shows a section through the engine. Each engine weighs about 515 tons and has a length of about 30ft. 6in. with a height of 35ft. 8in.

Aft of the main engines are the thrust blocks, and the $18\frac{1}{2}$in. propeller shafts are fitted with Stone's three-bladed manganese bronze propellers. They are 16ft. in diameter, with a pitch of 17ft. After carrying out the North Sea trials and docking at Gothenburg the propellers, we understand, were slightly altered, with a view to allowing full power to be developed at a somewhat lower engine speed.

In a double-acting internal combustion engine considerable interest always centres around the manner in which the valves are arranged in the bottom cylinder cover. In the engine we are describing the compression space on the bottom side of the piston is provided by casting in the lower cylinder cover a compression space offset from the main cylinder

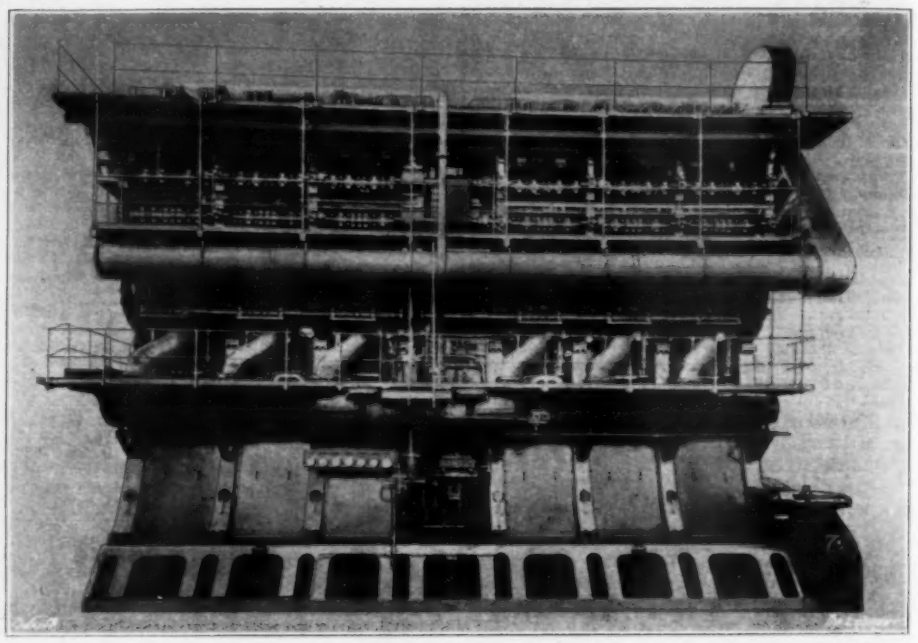


FIG. 2—6750 S.H.P. DOUBLE-ACTING OIL ENGINE OF THE MOTOR LINER GRIPSHOLM

walls. The piston itself has a hemispherical lower end which, on the bottom dead centre, coincides almost exactly with the shape of the bottom cylinder cover. In the centre of the bottom cylinder cover there is a large opening for the piston and stuffing-box. The stuffing-box is water cooled and is fitted with loose expanding rings. Drawing, Fig. 3, shows the grouping

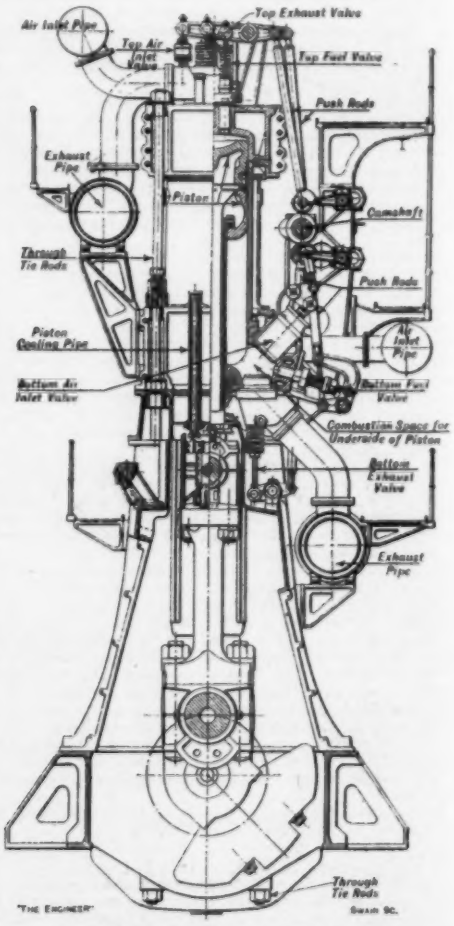


FIG. 3—SECTION THROUGH MAIN ENGINE

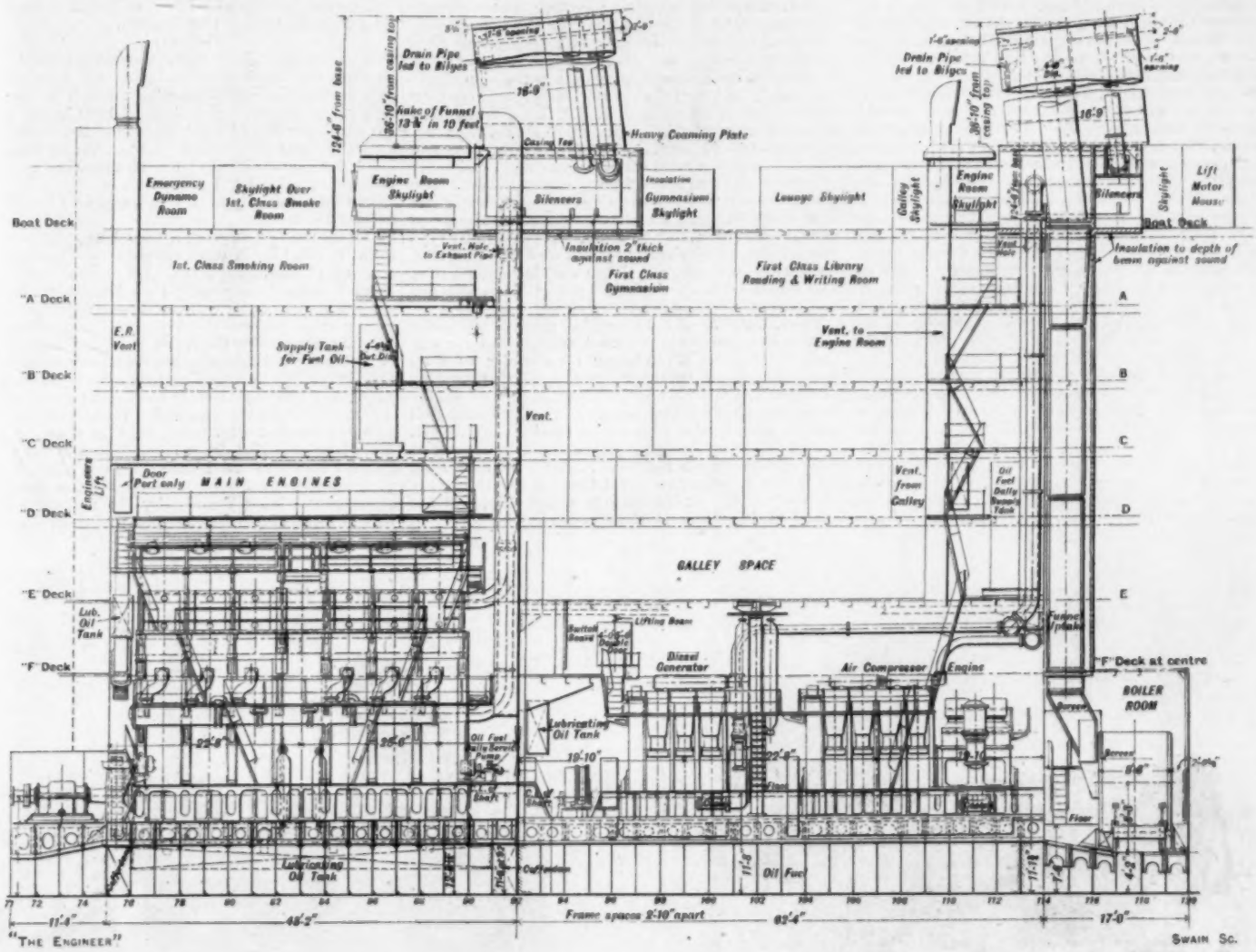
of the various valves, of which there are air inlet, exhaust, fuel and starting valves fitted to the top and the bottom cylinders. The arrangement of the top valve gear does not call for comment, as it is not different to that used on the single-acting engines. A view of the top gear is reproduced in illustration No I. of to-day's Supplement. Referring to the bottom cylinder cover, it will be noted that the exhaust valve with its vertical spindle is placed at the bottom of the compression space. The inlet valve is placed

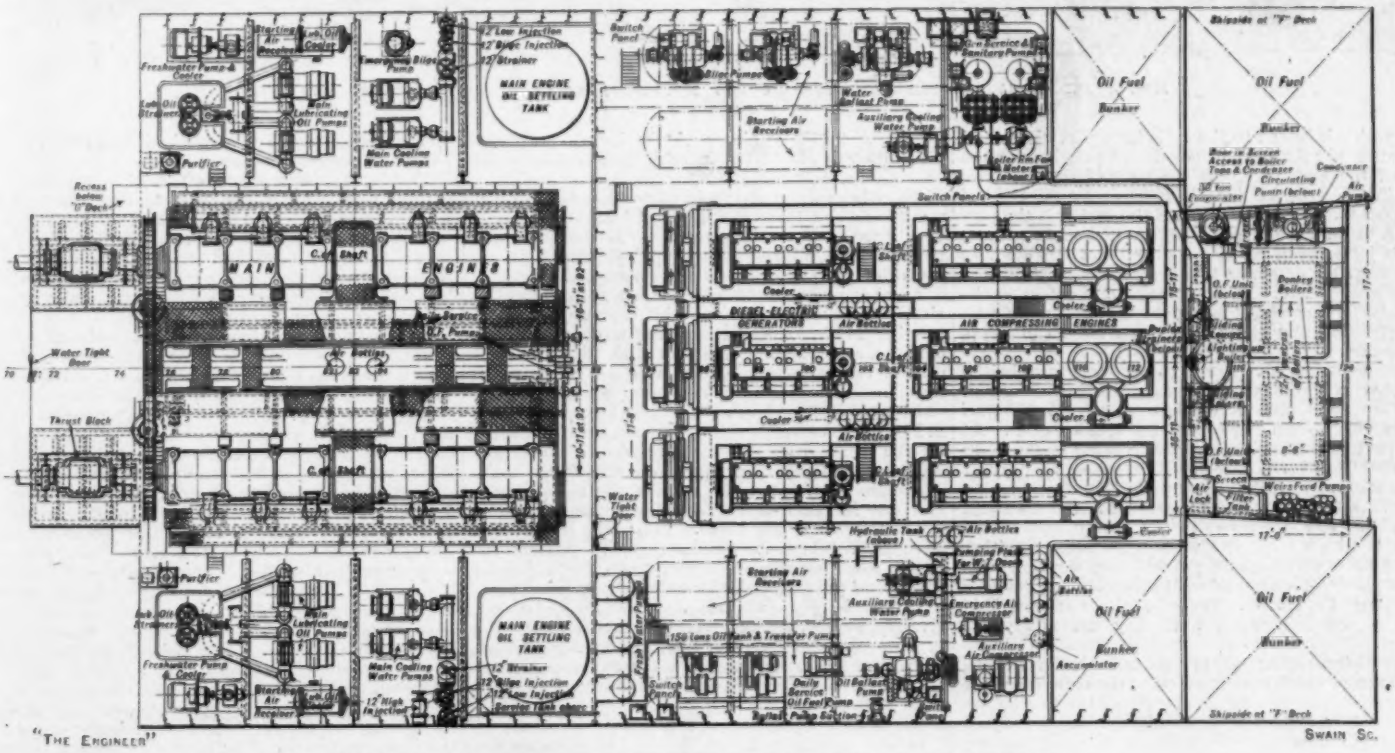
* No. I. appeared November 27th.

obliquely at the top, whilst the fuel and starting valves are grouped at the inclined end of the space. By arranging the fuel and starting air valves in this manner a clear flow of air or oil charge to the main cylinder space is given and the hot compressed air is gathered well around the mouth of the fuel valve. A design of fuel valve is employed which does not pressure of about 470 lb. to 480 lb. per square inch being employed and a mean effective pressure of a little over 90 lb. per square inch.

The cam shaft—see the drawing Fig. 3 and the Supplement view No. II.—is placed about halfway between the bottom and the top cylinder covers, and it carries ahead and astern cams for operating both arranged that any one cylinder with its top and bottom covers and valve gear can be completely removed from the engine without dismantling the cam shaft.

The main drive from the crank shaft to the cam shaft consists of two roller chain drives, each of which is designed to take the full working load. A centrally





FIGS. 4 AND 5—THE MACHINERY INSTALLATION OF THE MOTOR LINER GRIPSHOLM

allow the oil spray to meet the piston-rod. In the accompanying Supplement, Illustration No. V., which was taken at the third platform level, shows the general appearance of the bottom valve gear. It may be stated that both the top and bottom combustion takes place on the full Diesel cycle, a compression sets of valves. Immediately above and below the cam shaft will be seen the excentrically mounted reversing shafts, which lift the cam rollers free from the cams, whilst the reversing process of sliding the ahead or astern cam into position is carried out. All three shafts are carried on bearings, which are so placed casing encloses this drive and it stands free at the engine centre so that, like the engine, it can easily conform to any elastic deformation of the ship's hull. At the bottom of this same casing are placed the fuel pumps and the main controls—see Supplement illustrations Nos. III. and IV. It will be seen

that there are two groups of pumps, which serve the top and bottom fuel valves respectively. The manœuvring controls and the reversing system are identical with those used on the Burmeister and Wain single-acting engines. They comprise a servo motor with a rack and pinion gear for moving the reversing shafts and lifting the rollers from the cams, sliding the cam shaft and replacing the cam rollers. An emergency hand-operated gear is also provided. The two levers shown in the quadrant are the starting and speed control levers, which admit starting air to the cylinders, and, after the air has been cut off, bring the fuel pumps into action.

Having referred to the valve gear some mention may now be made to the main running parts and the method of engine erection. It will be noted from drawing, Fig. 3, that through tie rods are employed which pass right through the columns and bed-plate, so that the top cylinder cover, the cylinder liner, the bottom cylinder cover, with the columns and the bed-plate are held firmly together. Each tie rod is made in two parts, which are jointed by means of nuts that rest on the upper surface of the bottom cover. When erecting the engine the lower halves of the tie rods are placed in position and each rod is given an initial stress by tightening up the middle nut after a thin steel liner $^1/_{10}$ of a millimetre in thickness has been placed under the nut. The upper parts of the tie bolts are then screwed into the nuts and the top nuts are tightened down just so far that the middle nuts are lifted and the thin liner can be withdrawn. This simple method provides a certain means of obtaining a correct adjustment of the top cylinder cover after the piston has been removed for overhauling or inspection, whilst the cylinder liner can in a similar way expand without causing undue stress on any part of the engine.

The cylinder liner has an outward turned flanged end, which is bolted to the cylinder cover. It should be noted that the piston rings do not pass beyond the top of the liner and that the part of the cylinder, cast in one with the liner, is filled up by the head of the piston. A useful feature of the design is the provision of an annular space at the liner and cylinder cover joint, both on the top and bottom cylinder covers, with a detection hole communicating with the outer atmosphere. By this means any defect in the cylinder joint can be at once detected and the tightening of these important joints can be at all times controlled.

The cylinder covers are square and are bolted together in threes, which gives a rigid construction. Between each pair of columns there are distance pieces which form the top of the crank casing. At this part of the engine a special scraper stuffing-box is fitted round the piston-rod in order to prevent lubricating oil from travelling up in to the combustion space. A forked type of connecting-rod is used and the piston-rod is secured to the square part of the crosshead by a nut. Guide shoes are fitted at either end of the main crosshead pin and they work on loose guide plates which are bolted to the columns between each pair of cylinders. The guide shoes are provided with forced lubrication and they are not water cooled.

The piston-rod is made of steel and is furnished with a top flange which is tapered off to the main diameter of the rod. To this flange are bolted the two halves of the piston, and at the bottom of the piston is fitted a long cylindrical liner which is centred at the bottom of the piston-rod. Between the rod and the liner an annular space is provided for the lubricating oil which is used to cool the piston. A telescopic pipe is fitted to the end of the crosshead pin between each pair of cylinders with two passages within it which serve to take the flow and the return piston-rod and piston cooling oil. The entering oil finds its way to the bottom of the piston-rod liner and passes up the annular space and through holes bored in the flange to the head of the piston; it returns through a central channel bored in the rod and passes out through a discharge pipe into a slotted stand pipe arranged in the column, after which it is taken through a visible outlet to the bottom of the crank casing.

Main Engine Auxiliary Pumps.

The pumps for supplying cooling water to the cylinder jackets and for maintaining the forced lubricating oil circulation on each main engine are electrically driven and are placed on the outboard sides of the after engine-room, as shown in the plan drawing, Fig. 5. A view taken in the starboard wing of the engine-room is reproduced in Fig. 1 and shows the general arrangement of plant at that side of the main engine-room. For each engine there are two complete sets of pumps for main cooling water and lubricating oil service and one set is used as a standby set. The main cooling water pumps provide sea water for general cooling and are shown in the foreground of illustration Fig. 1. They are of the centrifugal type and are driven by electric motors at a speed of 1000 revolutions per minute. High and low inlet valves and strainers are provided, both at the starboard and port sides of the ship.

Fresh water is used for cooling the main cylinder covers and jackets in a closed circuit, and for this purpose there is a condenser type cooler with an electrically driven centrifugal pump. A compensating tank for the fresh water is arranged in the engine hatch and supplies each engine. The lubricating oil pumps are of the Burmeister and Wain special rotary vane type and are also electrically driven at 1000 revolutions per minute. A supply of lubricating oil is drawn from two drain tanks fitted below the engines in the double bottom of the ship, and the pumps deliver the oil through twin strainers and an oil cooler to the engines. A De Laval centrifugal oil purifier is also fitted in each main engine lubricating oil circuit.

On either side of the main engine-room at the forward bulkhead there is a large oil fuel settling tank, which tanks are filled by two 30-ton per hour motor-driven oil fuel supply pumps fitted at the centre of the engines near the forward bulkhead.

Another pump in this engine-room is the Drysdale electrically driven emergency bilge pump, shown to the right in Fig. 1. Near the pumps in the engine-room are the air starting receivers with the necessary control valves, whilst the injection air receivers are fitted near the control station between the engines at bottom platform level. The drawing we reproduce in Fig. 4 also serves to show the arrangement adopted for the main silencers, which are placed in specially constructed houses arranged on the boat deck. There are two silencers for each of the main engines and one for each three Diesel auxiliaries installed in the forward engine-room. Particular precautions have been taken, it will be seen, to insulate the engine-room as regards sound from the adjoining spaces and passenger accommodation.

The machinery is well arranged and ample space is given for supervision and overhaul. It was interesting to note that each special pipe circuit for oil fuel, lubricating oil, fresh water or salt water was painted a different colour so that the engineers on duty have little difficulty in following out the various pipe connections.

In our third article we propose to describe the Diesel compressor units, the Diesel-electric generating sets and the various pumps and machinery installed in the forward engine-room and boiler recess.

The Isle of Man Legislature is considering the expenditure of £750,000 on the improvement of Douglas Harbour by the extension of the present breakwater by 900ft.

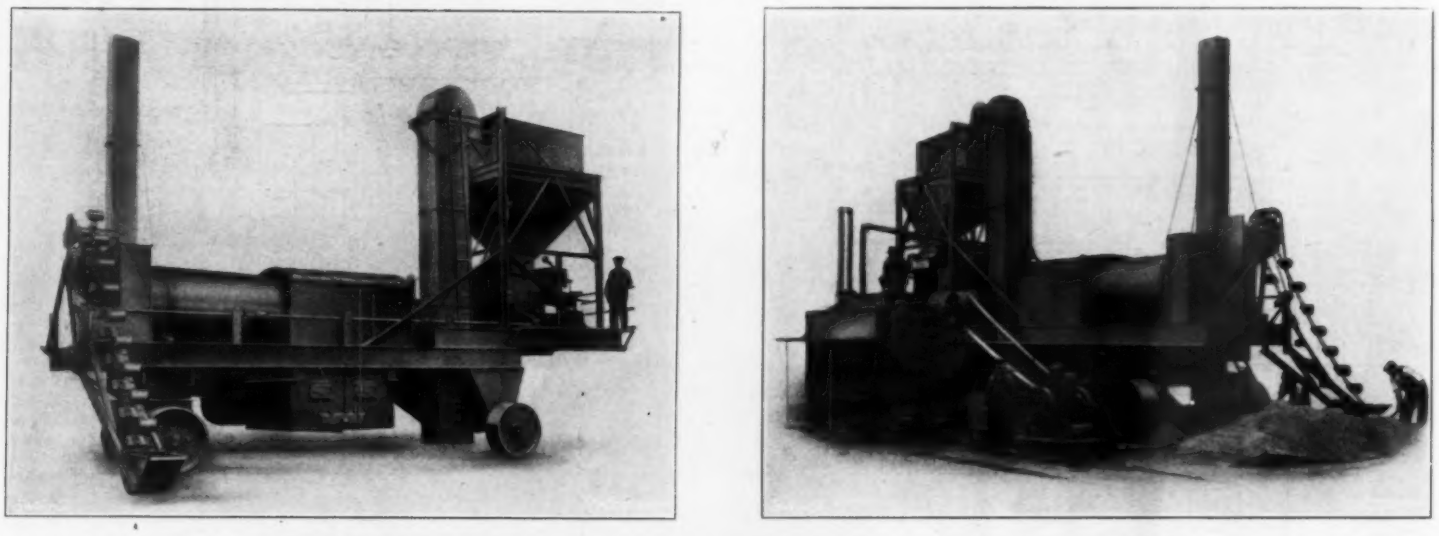
The Public Works, Roads and Transport Exhibition.

No. II.*

We continue below our description of some of the exhibits at the Public Works, Roads and Transport Exhibition, which was held in the Royal Agricultural Hall from November 19th to 26th.

Stothert and Pitt, Ltd., showed as their chief exhibit their latest type of 10-ton per hour asphalt and bituminous macadam plant, which is designed to give its output—equivalent to 1000 square yards 2in. thick per day of eight hours—on the assumption that the moisture content of the undried materials is 10 per cent., and that the temperature to which they are raised is 450 deg. Fah.

In this plant, which is illustrated in Figs. 12, 13, 14 and 15, the raw stone is first raised from a boot by an elevator to a rotary drying drum. This drying drum is 4ft. 6in. in diameter and 16ft. long, and is built up of mild steel plate, $^5/_{16}$in. thick. Internally there are fixed longitudinal blades, which lift the materials and cascade them through the hot gases during their passage through the drum. There are special means inside the drum to ensure that all sizes of material shall take the same time to pass through, and, hence, that all shall assume a uniform temperature. The major portion of the drum passes through a furnace, while the remainder is jacketed with an asbestos blanket $\frac{3}{4}$in. thick, kept in place by steel plate lagging. The drum is supported at both ends by cast iron gun-metal bushed rollers, which engage with mild steel roller paths riveted to the drum, this arrangement being deemed by the makers superior to the usual single bearing placed at the discharge end of the drum. The drum is driven by cast iron machine-moulded band gear.



FIGS. 12 AND 13—10 TON PER HOUR ASPHALT AND BITUMINOUS MACADAM PLANT—STOTHERT AND PITT

The furnace has a grate area of 32 square feet, and is fitted with two cast iron firing doors. The furnace body is constructed of rolled steel plates stiffened with angles and lined with fire-brick, 3in. thick, the crown being built up with cast iron ribbed plates. A chain-driven fan provides forced draught to the furnace. It is mounted on ball bearings, and is driven by roller chains and sprocket wheels.

From the drying drum the hot material is fed through a chute to an enclosed elevator, which delivers it to a revolving screen, 7ft. long by 3ft. in diameter, where it is graded into two sizes. The chute is made of mild steel plate, and is lined with a renewable wearing plate, $^3/_{16}$in. thick. It is also furnished with a door which enables a sample of dried material to be taken at any time to determine its temperature, though a pyrometer can be used for that purpose, if desired. The elevator is totally enclosed to conserve the heat of the material as much as possible. The elevator casing is made of steel plate, $\frac{1}{4}$in. thick, and it is fitted with malleable iron chains and buckets, the buckets being mounted between double chains running on jockey pulleys. This arrangement eliminates slats and runners, which Messrs. Stothert and Pitt regard as useless in this type of elevator, owing to the extreme friction and wear to which they are subjected. Two springs are fitted to the bottom bearing to minimise shock, and also automatically to take up the slack of the elevator chain brought about by the heat. At the top of the elevator there is a by-pass chute to prevent the large aggregate from passing through the screen, and to pass it by way of the chute direct into the storage hopper. The screen is made of wire mesh with perforations to suit any desired size of material. From it the materials pass to a storage hopper, which has a capacity of 147 cubic feet, and is divided into various compartments suitable for the

* No. I. appeared November 27th.

10 TON PER HOUR ASPHALT AND BITUMINOUS MACADAM PLANT

STOTHERT AND PITT, LTD., BATH, ENGINEERS

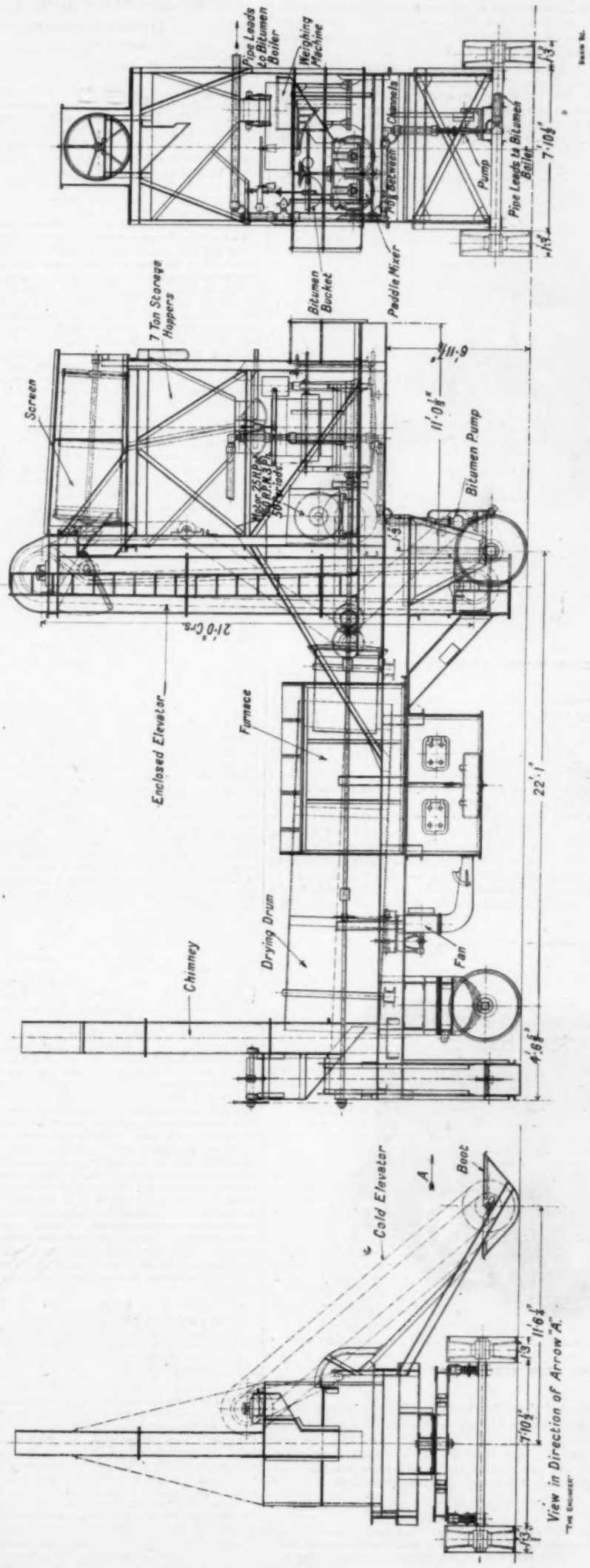


FIG. 14

grading of the material, each compartment being supplied with a bin gate, operated by means of hand levers. Under this storage hopper is a weighing hopper, having a capacity of 9 cubic feet, which is mounted upon an Avery platform weigher of the usual design. It has three beams to permit of three grades of materials being weighed. Two of the beams are graduated from 2 lb. up to 800 lb. by 2 lb. stages, and one beam is graduated from 2 lb. up to 200 lb., also by 2 lb. stages. The beams are enclosed in a wooden case, with a glass front, which is dust and weatherproof.

From the weighing hopper the materials pass to a paddle mixer of the double-screw type, which has a capacity of 9 cubic feet. The upper part of the body of this mixer is constructed of mild steel plate, $\frac{3}{8}$in. thick, whilst the renewable bottom plates are made of cast steel, $\frac{1}{2}$in. thick, and strongly ribbed. The ends are made of stoutly ribbed cast iron lined with

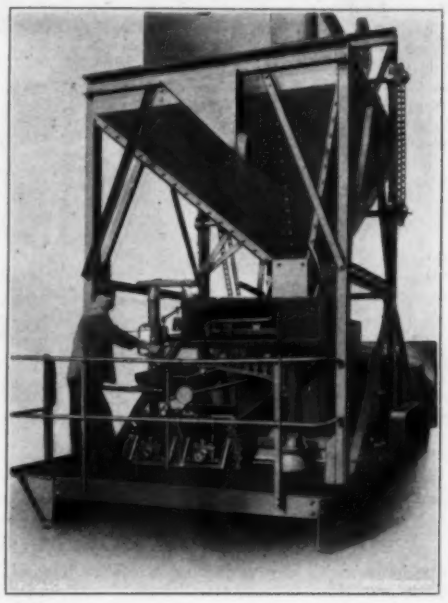


FIG. 15—OPERATOR'S PLATFORM

$\frac{3}{8}$in. renewable mild steel wearing plates. The paddles, which are of cast steel, are mounted on mild steel shafts of square section. The mixed material is discharged from the bottom of the mixer through a sliding door which is operated by a quick-acting screw rotated by a hand wheel.

The bitumen or asphalt is weighed in a mild steel bucket, suspended upon a steelyard weighing machine, which reads up to 150 lb. by 2 lb. steps. The bucket is mounted on spindles, and is furnished with handles for tipping it. The plastic material is pumped direct into the weighing bucket from the heater, through steam-jacketed piping. The pump is driven by belt from the main driving shaft of the plant.

The main frame of the machine is built up of mild steel rolled sections, specially strongly braced and tied together with a view to withstanding the rough usage which plants of this kind experience. It is mounted on road wheels with pressed steel disned centres and rolled steel rims, 3ft. 6in. diameter by 15in. wide on the face. The forecarriage, which is furnished with a mild steel draw bar, is mounted upon leaf springs, and is made to swivel until full lock, so as to enable the plant to be turned in a minimum of space. A driver's mild steel chequer plate platform is provided as part of the plant around the mixer, and all the operating levers are so arranged that one man can effect all the operations necessary for weighing, mixing and discharging.

Marshall, Sons and Co., Ltd., of Gainsborough, exhibited their latest type of "Universal" roller, which is claimed to combine successfully the operating advantages of the standard three-wheel and tandem types of road rollers. The roller, which is illustrated in Fig. 16, has been specially designed to meet the requirements of modern road-making. It can be used equally well for consolidating road bottoms or for finishing the carpeting or top surfacings without, it is stated, developing the defects of corrugations. Its distributed weights are nearly equalised on its hind and front rolls, though a slight preponderance of weight is allowed on the hind rolls to give finishing effect. To enable the road surfaces to be finished to any predetermined camber, a patented divided or articulated back axle with positive control has been adopted. The trunnions or pivots for the axle units are placed horizontally, and each has its pivoting centre in the space between the inner edge of the roller rim and the hornplate of the boiler. An automatic lock, also patented, has also been introduced to prevent rocking motion on the front fork without interfering with the steering of the roller.

The steering gear, which is of the positive type, is actuated at will either by a steam steering engine or by hand wheel. The steering engine has automatic controls, which bring a reverse mechanism into

action to prevent over-running the steering quadrant. Only one hand wheel is used to operate either the power or hand steering device.

The motive power is supplied by a high-pressure double-cylinder engine, entirely enclosed by its cast iron frame, and lubricated by the splash method. The engine gives, so the makers inform us, the instantaneous reverse, which is of such vital importance when rolling on plastic material. The hind rollers are given a good overlap on the track of the front rollers, so as to obtain the same effect as is

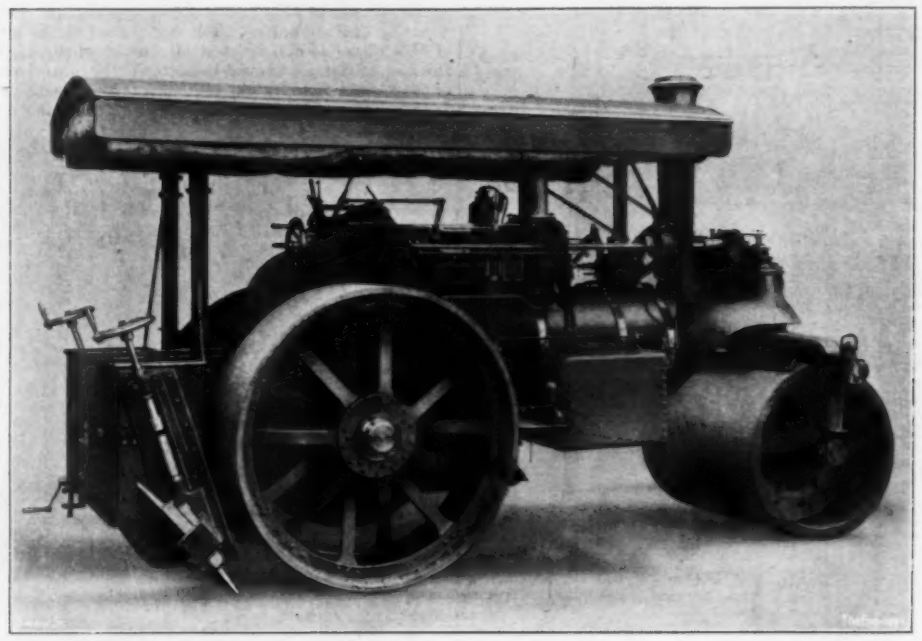


FIG. 16—9-TON "UNIVERSAL" STEAM ROAD ROLLER—MARSHALL

experienced with the tandem type roller. The boiler, which is of the locomotive multi-tubular type, works at a pressure of 150 lb. per square inch, and it is fitted with the "Marshall" patent corrugated fire-box. Alternative boiler feeds are provided by a geared down feed pump and a "Penberthy" auto-positive injector.

The open-back driving platform allows an "Allen" single-tine scarifier to be placed on either side of the roller, thus making it conveniently possible to scarify in narrow places without turning round. The transmission gearing gives two travel speeds forward and two backward, and the main gears work on the double-drive principle. A screw brake operates through the gears on the inner shaft, and a compensating motion is provided with an automatic lock. This compensating gear, which is of the "Marshall" four pinion type, is totally enclosed, and runs in an oil bath.

The equipment of the roller includes a water lifter, water sprays for all the rolls, a full-length awning, with side and end curtains, and a steam waste pipe from the safety valve.

The chief exhibit on the stand of Fodens, Ltd., of Sandbach, Cheshire, was the steam tractor, which is illustrated in Fig. 17, and the outstanding features of which are that it is fitted with three-speed gear and with the Ackerman steering mechanism. It is said to be capable of hauling with a trailer loads up to 10 tons at from 7 to 8 miles per hour on good roads, and of ascending gradients up to 1 in 7 at proportionately reduced speeds. The engine is compound, and has steam-jacketed cylinders, 4½in. and 7in. diameter by 7in. stroke. It is fitted with the maker's patented high-pressure gear, by means of which the engine can be instantly converted to double high pressure, both cylinders receiving high-pressure steam from the boiler and exhausting independently into the funnel. It is stated, that by using this arrangement, the power of the engine can be increased by about 75 per cent. for temporary use, such as starting a heavy load or ascending short, steep inclines. It also facilitates manœuvring in awkward places, since the necessity to use the reversing lever is much lessened because the engine will start in any position. The boiler is of the horizontal, multi-tubular, horizontal type, and the fire-box has been made specially large so as to ensure easy steaming with coal, coke or wood fuel. The fuel bunker is capable of holding sufficient fuel for a journey of 60 miles, and the water tank has a capacity of 280 gallons, which is enough to take the tractor fully loaded a distance of from 35 to 40 miles on good roads. An internal expansion brake is arranged to work inside the rim of each road driving wheel, and there is also a band brake operating on a large hub keyed to the main axle. A winding drum is fitted to the rear axle and 50 yards of steel wire rope are carried. The tires are of the rubber band type, single on the front wheels and twin on the rear. Altogether it is a sturdy and handy vehicle.

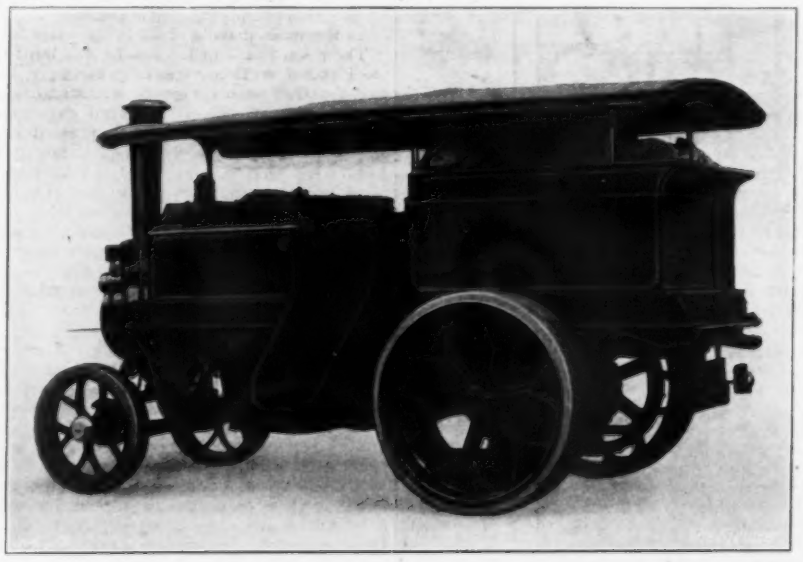


FIG. 17—STEAM TRACTOR WITH THREE-SPEED GEAR—FODENS

THE total output of coal from the mines of Great Britain for the week which ended on November 14th was 4,878,300 tons, as compared with 5,231,700 tons for the corresponding week of last year.

Characteristics and Uses of Ground Gears.*

By H. F. L. ORCUTT, of Birmingham, Member.

(*Concluded from page 591*)

PART II.

Uses.—The details given in the foregoing must be carefully considered before the ground gear can be correctly appraised.

The successive stages of evolution of the straight toothed spur gear are :—

The wooden cog of the old millwright.
The foundryman's gear with cast teeth.
The gear of the machine tool engineer, either milled, hobbed, or generated.
The gear hardened after the teeth have been machined.
And finally the gear with teeth ground after hardening.

The ground gear is undoubtedly a new class of gearing. It remains to be seen how far it may supplant other forms of transmission and to what extent it can be relied upon by the mechanical engineer in his power problems. Its virtues are not yet fully appreciated even in the motor car industry, where it is quite extensively used. The essential virtues of gears are quiet running, high speed capabilities, small size and long life. A combination of all these qualities is found in comparatively few motor car gear-boxes. The quiet, probably the silent gear, is now awaiting those motor-car makers who will adopt a suitable design of box and take the trouble to make other transmission details with the form and accuracy necessary for silent running. It is safe to predict that in time all motor car transmisson gears will be ground. The foolish and wasteful variety of sizes of gears will be got rid of, and gears with standard dimensions and with improved quality will be adopted. The time will come when practically silent transmission will be cheaply produced and available for every motor car. The much abused gear-box has not nearly completed its span of life, in spite of predictions of the protagonists of the "infinitely variable gear."

Recent trials have provided decided evidence in favour of the straight tooth ground gear being used for so-called "timing gears." Timing gear drives, both with helical gears and chains, have objections which nearly every engine maker would like to avoid. In one well-known car straight ground gears have been in use for some time, and there seems to be no reason why they should not work satisfactorily, if the teeth are specially accurate, as they may be if grinding is resorted to.

It is rather curious that the machine-tool makers have not yet made use of ground gears. The example of what can be accomplished in the motor car should be well known to them. Nevertheless, although nearly all now use "gear-boxes," not one has adopted the ground gear. In a few cases they are now being tried, and in the course of time the clumsy and noisy gear-boxes commonly used will be superseded. Customers will certainly demand better gears. Conditions which the machine-tool makers have to face in the near future will force the pace of adoption. These conditions are of a twofold nature: one is the fact that machine tool design has never really "caught up" with high-speed steel; the other is founded on the probability that non-ferrous metals—some of the newer bronzes—will very largely replace cast iron. If this occurs, cutting speeds will have to be increased much beyond the present fastest speeds, and in such circumstances the gears as now used will be perfect "howlers," intolerable for noise alone, to say nothing of short life with costly upkeep and expensive renewals. The machine tool maker should be more than thankful to the motor car engineer, who has solved half his problems of gear drives for him if he only knew it. Ground reduction gears for electric motor drives will probably be extensively made use of by the machine tool maker, that is, single reduction gears of comparatively small dimensions and run at high speeds, using small power motors, with gear mountings adapted to these conditions.

An important application of ground gears is beginning to interest electrical engineers. The ground gear has many features which make it especially applicable as a direct reduction unit between the motor and axle of electric locomotives. It is simple, smooth running, quiet, will stand very high speeds, can be of small dimensions, has a high factor of safety, and long life. So far as applied it has demonstrated its safety and life and smooth running. It has not, however, been made use of with dimensions and speeds outside of the specifications used for soft steel. The dimensions stipulated are very much in excess of those which are safe. Why is a factor of safety of sixteen necessary? There is much to be done in the way of standard specifications for this gearing. Specifications now usually given are meaningless; as far as fixing limits are concerned they are of no use. The requirement that a gear tooth must be accurately cut with a 14½ deg. pressure angle, is capable of a wide interpretation. Back-lash, indexing errors and excentricity are of vital importance in high duty gearing. Tooth forms are not of much importance as long as they are exact, although design of forms should be considered for each special service and ratio.

A specification for railway traction gears should include :—

(1) Smooth finish on teeth.
(2) A maximum back-lash of 0·02in.
(3) A maximum back-lash variation of 0·002in.
(4) Parallelism of teeth, maximum error of 0·001in.
(5) Index errors from tooth to tooth in gear and pinion not exceeding 0·0005in.

It is strongly recommended that research work, especially on electric traction gears, be undertaken, as there are practically no data available for this new class of gearing, which in the near future may be extensively used. The hardened gears not ground, now quite extensively in use, both for main line and tramways, are very inaccurate, so inaccurate that it is quite possible they are actually *preventing* the electric railway engineer from making distinct improvements in his power unit.

So far as is known, the ground gear is not used by any electrical engineer in ordinary engineering speed reductions, so commonly demanded where direct motor drive is employed. There is a very large possible application in this particular direction. The ground gear for motor

* The Institution of Mechanical Engineers.

drives will certainly replace in many instances helical gears, laminated gears, fibre gears and chain drives, in many cases saving in first cost as well as giving an equally quiet and a more lasting service. There are many cases where helical gears are used to secure quiet running where end thrusts are undesirable. In these cases the straight tooth ground gear may possibly be used as a satisfactory substitute.

For anything except comparatively slow speeds it is now impossible to make use in gearing transmission of the alloy steels with extreme physical properties. When the teeth of gears are ground after heat treatment the engineer has an unlimited choice of metals, he can select that which gives him strength combined with light weight and small sections, or large sections giving the maximum life and with standing severe shocks and loads. Two extremes may be cited :—

(1) In the aeroplane where light weight and reliable service are indispensable.

(2) In a rolling mill gear, where breakdowns and repairs are costly, and heavy loads and shocks are not to be avoided.

It is quite possible that chain transmissions will be replaced in many instances by ground gears, giving full reliability, quiet running, a saving in first cost, and in weight and troubles due to stretching chains.

Whether ground gears will be used for turbine transmission very extensively or not it is impossible to say. They have been in service for some time but only to a limited extent. Gear grinding on large diameters with fine pitches has not been very much developed. There is, however, no reason why it should not be successful. It will certainly be available in the near future with every degree of accuracy now found in small ground gears. When it becomes possible to grind the teeth of a large diameter gear with a fine pitch made from alloy steel, heat treated and finished with the surface which only an abrasive wheel can produce and with the same accuracy as is now secured in small gears, quite unexpected results, which should be of special interest to the turbine engineer, may be attained.

A further use is anticipated in gears where heavy loads are carried and which, made of soft material, wear out quickly. In many cases such gearing is replaced at very great expense, chiefly on account of costs incurred through loss of output while repairs are undertaken. If gearing that will last, say, six or nine months, instead of three months, can be put into such plants, first cost will be of little consideration. Incidentally, for this class of gear better running will be secured in the ground gear. Gears will run quietly and comparatively close back-lash will give long tooth life. For this service where large diameter gears are necessary, the so-called composite gear may be used, with the rim only made from the more expensive material.

Methods of Grinding.—Two methods of gear tooth grinding are in use : one is adopted by those who have developed the so-called generating machines ; the other by those who employ the formed wheel. There are now on the market half-a-dozen different machines of the generating type. In some of them a very large grinding wheel is employed, and the width of gear is limited to about 1in., as no motion either of the gear being ground or of the wheel parallel with the axis of the gear takes place. In other generating machines there is a reciprocating motion as well as a rolling ; on these machines gears of wide face can be ground. In one other type of gear grinder the tooth form is dependent on an involute form from which the gear teeth are "generated." In some generating machines only one side of the tooth is ground, in others both sides of the teeth are finished at once.

In the machines using the formed wheel the entire tooth space is acted upon by the formed wheel revolving while passing through the tooth space. On them, width of gears to be ground is limited to the traverse of a reciprocating slide carrying the formed wheel. So far as is known none of the formed wheel type of machines are on the market, at least not in the European market.

It has been found necessary to devise and make entirely new measuring instruments for inspecting the teeth of ground gears and for checking index errors. These instruments are very interesting and absolutely necessary to the production of ground gears. They are of little practical use in the production of cut gears.

PART III.—RESEARCH.

Gear tooth grinding is now on a commercial basis, and gears with accurately ground teeth are available, but not in very large dimensions. The principal development, of course, has been in connection with motor car transmission gears. Quite a lot has been done on gears for electric traction work. For this class of work gears can now be ground in a commercial basis up to about 3ft. diameter and 8in. wide, and two diametral pitch. Little or nothing has been done on gears with a finer pitch than 12 diametral. Any material can be ground. The process has been so far tested in motor car gears as to demonstrate conclusively that the cheapest way to get a quiet gear is to have the teeth ground. Gears for aeroplanes have been successfully ground in considerable numbers.

It should be noted that the future of gear grinding will not be confined to hardened gears. Wherever extreme refinements in tooth contact are called for, the ground gear will supersede the cut gear, without regard to the material used, be it brass, fibre, cast iron or soft steel. There is now a demand for unhardened straight toothed spur gears with an accuracy which is practically impossible to produce uniformly in the cut gear. It is believed that gears finished on the gear tooth grinding machine meet this demand.

Much research work is necessary on straight toothed gearing. It is important to make tests and experiments with the special object of fixing the limitations of cut gears ; these limitations are pretty well known for cast iron and soft steel. They are not, however, sufficiently well defined on hardened gears in respect of loads and life. Maximum allowable errors for specific services are not recorded. It is desirable that that should be done, especially for gears made from alloy steel treated to withstand heavy loads and shocks.

Gear tooth grinding is now sufficiently advanced to indicate that further progress in spur gears is almost wholly a matter of accurate finish, and that extensive research on high-duty cut gears is either useless or impossible.

The study of faked forms may be dismissed as of no value. Thorough investiagtion as to the extreme loads and speeds which gearing will stand are impossible, except on gears the tooth surfaces of which are a close approximation to the theoretically correct involute.

The ground gear opens a new field of research. Gear tooth grinding specialists themselves do not yet know the exact limits of accuracy called for by special gear service. It is difficult to lay down an exact programme of research. One of the first things to determine is the maximum practicable accuracy of cut gears, both soft and hard. In this work it will probably be necessary to make use of ground gears finished with predetermined *inaccuracies*.

When the engineer knows definitely how far he can rely on cut gears, he can decide when he must make use of ground gears. The next step in research work should be made with a view to fixing data for ground gears. Enough facts are known to warrant extensive tests. These tests may be broadly subdivided under —

(1) Endurance or life.
(2) Speeds.
(3) Noise.
(4) Loads.
(5) Accuracy, limits of error and effects of same.

It will probably be found necessary also to make what may be termed minor tests, the nature of which will be explained further on.

Endurance.—Tests should include gears made from alloy steels, air hardened, oil hardened and case hardened. It is especially important to carry out endurance tests on the case-hardening steels, which give such a wonderful service in the ordinary motor car gear-box. A special study should be made as to how far a smooth tooth finish affects the life of gears. Undoubtedly the life of a gear is affected also by the accuracy of the teeth, although the extreme accuracy necessary for quiet running may not be required for long life. It is desirable to investigate to what extent accuracy alone does affect endurance.

In connection with endurance tests, separate investigation should be made to determine what materials and treatment are most suitable for spur gears which have to stand severe shock and reversal loads. These tests are especially required for gears used for electric traction purposes, or for services like rolling mills or tube mills. For this latter service long life is also a valuable quality, as repairs and renewals are very costly.

Special investigation might be desirable on motor car gears as to the best material for clashing gears. Gears for this service have to bear heavy running loads, but only for short periods, and they must withstand excessive wear from clashing.

Speed Tests.—That gears running at high speeds must have exceptional accuracy is beyond question. If they are inaccurate they will be noisy and short lived. The limits of accuracy in relation to satisfactory running at high speeds are not definitely fixed. Gear grinders know that certain limits must not be exceeded for a certain service. These limits are finer than those called for in any ordinary mechanical operation, almost as fine as are common in gauge work. The relative importance of the various tooth errors is not thoroughly understood. The various measurements must include tooth forms, indexing, excentricity, parallelism, and tooth depths. A series of tests on each one of these dimensions is necessary to determine how far individually they affect good running.

In connection with these tests, lubrication must be investigated. For very high peripheral speeds both the quality of the lubricant and method of application must be considered.

Tooth Areas.—There is very little definitely known as to the tooth areas and loads. Investigation of these details is of extreme importance. Tests to destruction will be necessary. Experience with motor car gear-box gears and aeroplane gears indicates that quite small tooth areas may be used as compared with common practice. Many motor car gear-box gears bear loads of over 3000 lb. per inch of face, some 4000 lb. As these loads are only required for short periods, it is not altogether safe to adopt them for continuous running.

Noise.—It is definitely known that extreme accuracy of tooth form is indispensable to quiet running. The exact relation of accuracy to speed is not known, neither has it been definitely ascertained how far different sorts of inaccuracies are responsible for different noises. Gear grinders are, of course, dealing with these problems daily. The art is sufficiently advanced to give good results, but not enough to satisfy demands for real "silence."

It is known that beyond certain errors quiet running may not be expected. It is desirable to know how quietly gears will run when they are ultra accurate, and, of course, how far extreme refinements are commercially attainable.

Minor Tests.—To cover what may be called minor tests includes a study of pitch, angle of tooth pressure, ratios, arc of action and number of teeth in contact. Some curious and as yet unexplained troubles occur in certain gear ratios. The same troubles do not occur in other ratios. These discrepancies may disappear with further perfection in production.

It is suggested that, possibly, very useful data might be secured by tests of certain ratios in which the design of the teeth varies, for instance, with different pressure angles or modified addenda and dedenda, varying these details on a series of tests of gears without varying the ratios.

Efficiency.—In respect of loss of power in transmission, possibly there is not very much difference between super accurate gears and very good cut gears. Still, there must be a difference, and it should be known. With the ground gear it is possible to make comparative tests which have hitherto not been of much value.

Distortion Measurement.—Exact distortion records are certainly desirable, especially for the cut gear. It is necessary for the ground gear as a means of saving production costs in grinding. It is, of course, uneconomical to grind off more stock than is necessary. We should have more definite knowledge as to the differences in distortion between the oil-hardened and the case-hardened gear. In the case of the hardened gear, it is desirable to have the hardened surface as uniform as possible, as it is well known that the hardest portion of gear teeth is on the surface. Distortion tests are not difficult, as they involve only measurements and not much mechanical outfit. It is suggested that these tests may include gears which are accurately ground *before* hardening.

Mounting Gears.—It is apparent that gears with small tooth areas from which long life, high speeds and quiet running are expected must be correctly mounted. Before accurate gears were available, investigations in this important matter were not of very much use. Research in gear mounting is now a necessity. Difficulties with accurate gears are common, and there are many disappointments experienced with those who expect the ground gear to cure all their troubles. Motor car engineers are just beginning to recognise this problem. In many cases it is found that gear-boxes themselves must be entirely redesigned or details altered before gears will run quietly. In other cases engine and back-axle defects, or peculiarities, make themselves objectionable in the gear-box. Connections have to be altered and isolation studied. Certain patterns of gear-box cases seem to be specially designed to magnify vibrations ; some are perfect sound boxes. It is well known that the *silent* ball or roller bearing is not yet made. Some are more noisy than others. Limits of workmanship in gear-boxes need defining. Some are important ; some are not. Exact centre distances are not so important as parallelism of shafts. Clearance in ball races needs investigation. Resonance certainly must be a matter for a considerable amount of study before the gear-box is completely satisfactory. The fact is that the much abused gear-box is nowhere near perfected. It may have a new lease of life when its defects are mastered. It is a mechanism much more worthy of improvement than of execration.

Marine engineers have been obliged to give serious consideration to gear mounting as well as to the development of exact gear teeth. It has been found that certain reduction gears will give satisfactory service in one position and will invariably break down if placed in another position between the turbine and the ship propeller.

It is quite likely that important improvements in electric traction will be made in gear mounting when the electrical engineer fully realises the great inaccuracies of many gears now in use in railway and tramway service.

Bearing Loads and Pressure Angles of Teeth.—Tests made some time ago indicate that the pressure angle of gear teeth does not have very much effect on the bearings, whether the pressure angle is 14½ deg., 20 deg., 22½ deg., or 25 deg. As pressure angles are increased there is a possible increase in bearing loads of not more than 6 per cent. The tests were made on cut gears. It is certainly desirable to make further tests with ground gears. It is very often necessary to good gear design to increase pressure angles. An alteration of this nature is often objected to on the academic assumption that increased pressure angles increase bearing loads to a degree that is possibly dangerous.

These suggestions for research are submitted for the special consideration of mechanical engineers. They especially indicate that there is a wide application of ground gears in industry. Aside from laboratory investigations, practical tests in actual working conditions are necessary. These tests entail very little expense, and if undertaken properly can be made at once useful as well as a guide for further developments.

No apology is made that this paper is quite as much a record of possibilities as of facts. Of gear tooth facts, fancies, and formulæ, there is literature in abundance. It is no exaggeration to state that gear tooth grinding opens a new era of practical progress in power transmission. As in any other art worthy of pursuit a revelation of present shortcomings and ignorance is necessary for intelligent progress.

Newspaper Conveyors.

IN the evolution and expansion of newspaper printing plants during the past two decades the problem of moving the printed papers from the press delivery belts to the posting and street delivery rooms has become increasingly important, because of the great increase in the size of the papers, the volume of the editions and the speed of production. While printing plants were small and circulations limited, the papers were carried by "flyboys" from the press delivery belts to the counting and bundling tables, usually situated in or near the press room. As the plants increased in size, handling larger editions of heavier papers, the mailing and delivery rooms were moved farther away from the press rooms, and it became necessary to employ carrier boys, trucks, flat belt bundle conveyors and hoists for transporting the papers from the press room to the posting or mailing room. Such means for handling papers were fairly satisfactory until the advent of the high-speed press, coupled with the phenomenal growth in circulation and volume of advertising. This necessitated moving the mailing room still further away from the press room, and then the rapid handling of a relatively large tonnage of papers required so many "flyboys," carriers and trucks as to increase the costs of production, besides delaying transit of papers to the mailing room, and resulting in confusion all round.

With the development of the high-speed press, it was only logical that some means should be devised for taking the papers directly from the press to the mailing room, without any intermediate handling. The means first evolved for this purpose consisted of a system of flat leather or fabric belts in parallel pairs, suitably supported, and driven, between which the papers were carried in an overlapping stream from the fly belts of the press to one or more central delivery points in the mailing room, from which they were distributed manually to the counting, wrapping and mailing tables. This type of double belt conveyor served the purpose of speedily and economically carrying the papers to the mailing room, and eliminated the confusion occasioned by a large number of carriers and truckers, but it unfortunately had several defects. The natural stretch of the leather and fabric belts called for frequent adjustment to take up slack, and the belts gradually accumulated a coating of ink, oil and dust, which eventually caused smutting of the papers carried subsequently. To avoid this trouble, the flat belts had to be cleaned frequently, so that the maintenance of such conveyors in proper working order proved a source of expense and annoyance. The flat-belt system was also limited in its flexibility of installation, and could not be applied to all space conditions existing in various plants.

By substituting a round belt made of closely coiled

steel wire spring for the flat leather and fabric belts, the objectionable features of the older system have been done away with. The inherent tension in spring belts, when properly installed, makes them self-adjusting, and the highly polished surface of the steel wire prevents the belts from collecting ink, and so soiling the papers. Moreover, the round spring-like belts permit of much greater flexibility in the installation of the complete conveyor system, so that it is possible to install such conveyors under almost any structural conditions encountered in publishing plants.

When this type of conveyor employing the round coiled spring belts was first designed a few years ago, the entire structure was comparatively light, with bearings of the usual lubricated bushing type, and the various elements were not standardised for interchangeability and large-scale production. The first conveyors which were installed in connection with slow-speed or moderate-speed presses, printing comparatively light papers, served to demonstrate the practicability of the conveying system, but also indicated that the original structure was not adapted for the severe service conditions encountered in connection with the modern high-speed presses. During the past few years, however, the design and construction of this conveyor have been altered and developed until it has proved practicable for the heaviest work.

The modern conveyor consists of a system of coiled wire belts and rollers used to convey newspapers or magazines from the fly belts or delivery of a rotary printing press or a folding machine to some desired point in the distributing room. The papers can be carried horizontally, on an incline, or vertically, or, indeed, in any direction.

Structurally considered, this new conveyor consists of a rigidly braced skeleton framework of steel or iron pipe extending from the press folder to the delivery table, wherever that happens to be situated. Mounted on this framework at proper intervals are cast or malleable iron brackets supporting the shafts of suitable grooved wood or metal rollers and pulleys, over which run a number of parallel endless strands or belts made of coiled spring steel wire of a grade developed for the purpose.

At every point where the line of travel of the papers must be changed in direction through any appreciable angle, a "transmission unit" is installed. This unit consists of substantial cast iron side frames bolted together with heavy steel cross rods, which support the ball bearings for the shafts of the necessary transmission gears, sprockets and grooved iron rollers for deflecting the line of the conveyor travel.

The transmission situated at the press delivery belts, which is termed the "press connection unit," contains, besides the transmission gears, sprockets and grooved rollers mentioned, the auxiliary driving motor and reduction gearing between motor and unit, which is used for driving the conveyor to empty it of papers after the press is stopped. At the delivery table in the mailing room the transmission unit is incorporated in framework together with the delivery belts, and this entire unit is termed a "delivery table."

At intermediate points throughout the run of the conveyor, where the direction of travel of the papers is changed from a vertical to a horizontal run or *vice versâ*, the transmission unit is termed an "upper or lower corner."

Whenever the horizontal run of the conveyor is changed in direction, but still in the horizontal plane, a special transmission unit, termed a "horizontal turn," is installed. This turn consists of suitable framework carrying the necessary number of conical rollers for turning the papers through any angle from 10 deg. to 90 deg. in the horizontal plane, with bevelled gear connections between the cone-shaped rollers, as well as a bevel gear transmission unit for changing the direction of the chain drive.

As the papers pass from the press delivery belts into the press connection unit, the direction of travel is usually changed from the horizontal to the vertical, either upward or downward. These vertical sections consist of a double set of belts, the papers being gripped between the two sets. The grip of the belts on the papers is obtained by placing staggered bearing rollers on each side of the double belts and making the papers travel along a zig-zag path, thus rendering it impossible for the papers to slip out of place. On all horizontal sections, the papers rest on the top of a single set of wire conveying belts, except where excessive air draughts are present, in which case another set of belts runs on top of the papers so as to prevent them from blowing off.

The grooved pulleys and rollers carrying the conveying belts are independently driven by steel sprockets and chain from the press folder driving shaft, when the press is in operation, and therefore the entire conveyor system runs in synchronism with the press, preserving the proper overlapping relation of the papers regardless of the press speed. After the press stops the conveyor is driven by an auxiliary motor or by a hand crank to empty it of papers.

The papers are conveyed at a lineal speed of approximately 100ft. per minute, which means that it is only a matter of seconds after the press starts until the first paper reaches the delivery table. With an average overlap of 3in., the conveyor carries about four papers per foot of length, so that the first paper reaches the delivery table after about 100 or 150 papers have been printed, depending upon the length of the conveyor. The papers are usually taken from the press in what is termed a "half fold" condition, though provision can be made for carrying both "half fold" and "quarter fold" papers.

For a straight delivery from the press the speed of the conveyor is such as to carry the papers in overlapping relation with a lead of approximately 3in. between succeeding papers. For a "collect" delivery, where the papers are heavier, the speed of the conveyor belts is changed through a gear shift mechanism in the press connection to increase the lead to approximately 4½in.

To obtain the proper overlapping of the papers, the speed of the transmission belts is naturally much higher than the speed of the press delivery belts, and therefore in order to deliver the papers on to the delivery table in approximately the same relation as they are delivered to the press fly belts, the speed of the belts on the delivery table is reduced to correspond approximately to the same speed as the press folder delivery belts.

The twenty-fifth or fiftieth "count" paper, which is kicked out on the bias by the press folder, is carried through the conveyor and delivered in the proper "count" relation on to the conveyor delivery table.

The result of this transmission from the press to the mailing room is that the papers are laid down upon the delivery table wherever it is installed in practically the same relation as they are initially delivered to the press delivery belts, and from that point onwards they can be handled in stacks of 25, 50 or 100 papers, as in the usual procedure when the papers are taken directly from the press folder by flyboys.

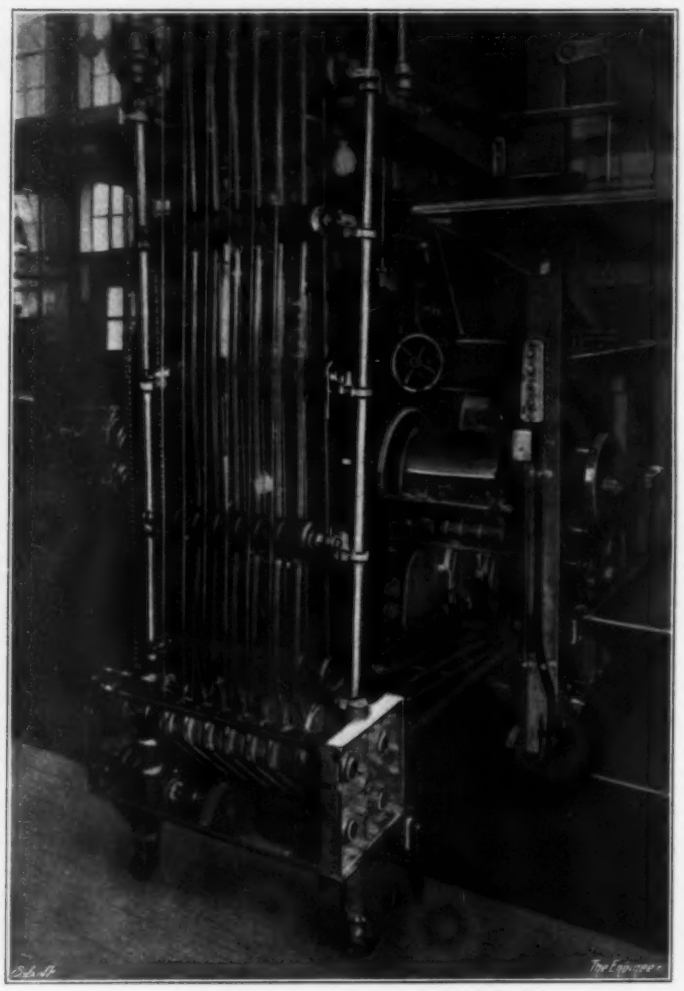
For a press having a single folder and single delivery, one conveyor serves to carry the papers from the press to the mailing room, and if necessary two or more delivery tables are placed at different points in the mailing room with provision for switching the stream of papers from one delivery table to another. Two or more delivery tables cannot be served from a single conveyor. If desired, a conveyor can be arranged to serve a delivery table on one floor for supplying the newsboys, and another delivery table may be placed in the mailing room on an upper or lower floor.

For a press provided with two folders and two deliveries, it is customary to install a conveyor for each delivery, and, in fact, this is necessary if it is desired to obtain service from both deliveries simultaneously. However, it is possible to arrange for running the papers from either of two folder deliveries into one main conveyor, with the understanding that only one folder and delivery at a time can be served by the conveyor, although in such cases the papers can also be taken from the other delivery by flyboys.

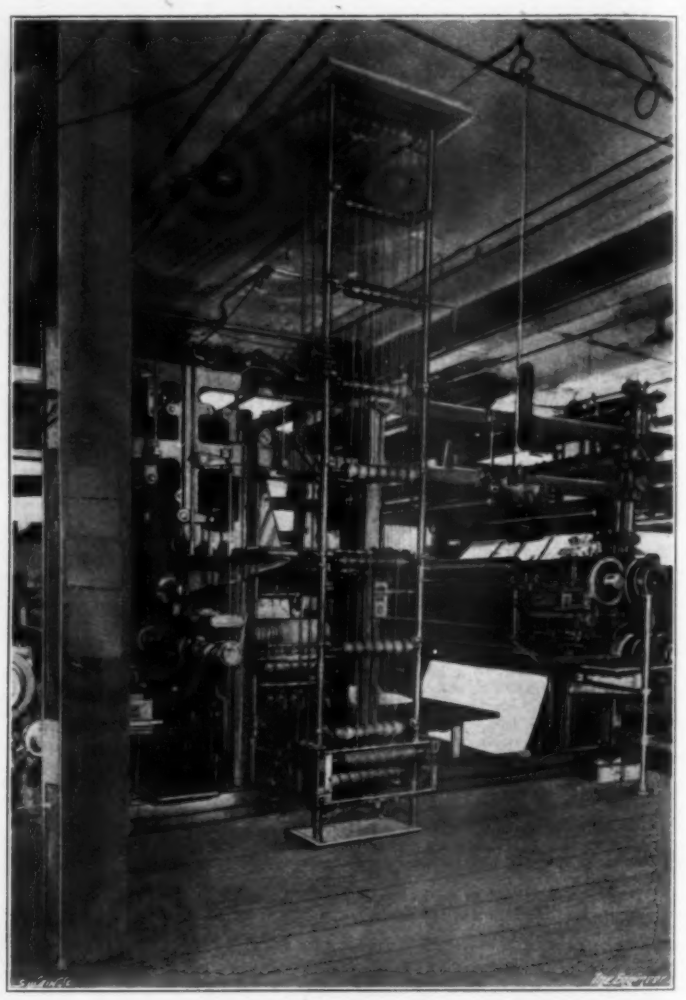
The flexibility of this new type of conveyor, which is of American origin, but is being made in this country by the Igranic Electric Company, Ltd., is such as to permit of changing the direction of transmission to almost any angle in the three physical dimensions, so that to avoid special obstructions in a newspaper plant, the conveyor may be run from the press upwards, downward or sideways, through ceilings, floors or side walls, and may be twisted through various angles in any direction of transmission.

The capacity of the conveyor is equal to the maximum possible printing capacity of any press to which it has been connected, carrying papers from a single sheet to the heaviest newspaper printed, at speeds up to 72,000 sixty-four page papers per hour.

The illustrations given herewith and on page 610 represent conveyors of the type described in the foregoing as applied to newspaper offices in the United States.



PRESS CONNECTION AND MOTOR FOR CONVEYOR



CONVEYORS HANDLING THE "MINNEAPOLIS TRIBUNE"

THE National Research Council of the United States is about to publish its "International Critical Tables of Numerical Data of Physics, Chemistry and Technology." It will be in five volumes, and the price to members of scientific societies is 35 dollars.

THE MARINE SPRING-LOADED SAFETY VALVE.

ONE would hardly have expected the boiler safety valve to provide an interesting history. Yet that it could do so in capable hands is shown by the paper which Mr. Donald MacNicoll read before the Institution of Engineers and Shipbuilders in Scotland on October 20th. The paper was called "The Jubilee of the Marine Spring-loaded Safety Valve." It seems that James Howden, in 1872, was the first to propose seriously the use of a spring-loaded valve. In the following year Mr. Hazelton Robson read a paper entitled "The Advantages of Springs for Loading Government Safety Valves of Marine Boilers Instead of Deadweight," before the Institution of Engineers and Shipbuilders. As a result, a Committee was formed, reported in October, 1874, and made representations to the Board of Trade, and the Board sanctioned the spring-loaded valve in 1875, but it insisted that if a spring-loaded valve were used, an accumulation trial must be held to ascertain the actual blowing off point. By as much as that point exceeded the blowing off pressure of the dead weight valve must the nominal working pressure of the boiler be reduced.

Mr. MacNicoll remarks that before joining Cockburns, Ltd., of Cardonald, eighteen years ago, he had always assumed that when passing steam at maximum pressure safety valves lifted one-fourth of their diameter, but soon found that ordinary direct spring valves only lift about one twenty-fourth of their diameter, or, in other words, give an edge area only one-sixth of the disc area. The problem, then, was to design a valve that would have a greater lift. In 1908 the safety valves on certain British destroyers were found to be too small, but it was observed that there was considerable steam pressure in the waste steam portion of the valve chest, and it occurred to Mr. Hamilton Gibson that this pressure might be used to increase the lift. He therefore fitted a valve which operated in that way through the medium of a cylinder and piston, which operated upon the easing lever. In H.M.S. Swift the arrangement was simplified by attaching the piston to the stem of the valve itself, a plan which had been used by French engineers for some time previously. The device was, however, not perfectly satisfactory, and Mr. Cockburn and Mr. MacNicoll brought out in 1912 the relay or full bore valve, which is now a standard naval fitting, whilst for ordinary commercial work the older type, modified, remains in use. Sticking or gagging had to be overcome, and Cockburns therefore made the piston loose on the spindle. Thus the valve can act in the earlier way should the piston jamb, but when working properly the first puff of steam drives the piston up against the spring, and it then acts to augment the lift. Finally, a further modified form which overcame all objections was produced, and was found to be so satisfactory that the Board of Trade agreed in May last to a 50 per cent. reduction in valve and waste steam pipe area when it is used.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Position.

THERE has been very little change in either the market or the industrial situation in the Midland iron and steel and engineering industries during the week. Business continues spasmodic and values in most departments leave much to be desired. There was only a moderate attendance on 'Change in Birmingham to-day—Thursday—and the business negotiated was not of any great magnitude. No mill appears to be working at anything like full capacity, and in the South Staffordshire district many are completely idle. Ironmasters re-rolling steel are finding a fair amount of business, but at the prices ruling something approaching capacity output is needed before business can be said to be remunerative. Some of the engineering firms are busy, but many still have to work short time. The tube trade, which was at one time a prosperous industry in this area, is slack and some local factories are only working three days a week. Midland rolling stock builders call for fair quantities of iron and steel from the Black Country, but other requirements fail to furnish the additional work necessary to keep the mills fully employed. Builders of rolling stock are assured of regular employment for several months to come. Machine tool makers are receiving a fair number of inquiries, while ironfounders are busy mainly in connection with the light engineering trades. Electrical engineers are still receiving news of extensions by public authorities. At the moment both Leicester and Worcester are considering such schemes. That the Patent Shaft and Axletree Company, which closed down recently, has been able to start two steel furnaces, with some mill plant, is welcome news. The iron department, however, remains unemployed.

Raw Iron.

The raw iron department is at the moment one of the best features of the Midland iron and steel market. Indeed, it is practically the only one showing expansion of business. Merchants report that consumers are buying more freely, and in larger tonnages. This activity is considered a healthy aspect, as the pig iron department has been in every respect the most unsatisfactory since the war, with numerous unemployed blast-furnaces. An occasional additional furnace is being re-lighted, but the main concern of buyers and sellers alike is to play for safety. Furnacemen have no need to look further than the steel branch to convince themselves that an improving demand does not necessarily spell the more profitable operation of plant. Values in this area continue firm, with a tendency to harden. Derbyshire No. 3 foundry is quoted £3 5s. to £3 6s., and forge £3 1s. to £3 2s., while Northamptonshire makers want £3 2s. to £3 2s. 6d. for foundry and £2 10s. for forge grades. That prices should have remained practically motionless for over a month is considered a good sign. If it does not prove any great revival in demand, it suggests that the firming up of prices in October was founded on a substantial improvement in consumptive requirements. November has not brought any expansion, but the position has not been perceptibly impaired except so far as the sentiment goes, and that was built largely on the expectation of continuous improvement. Blast-furnace coke values continue to harden, and the slightly better prices which blast furnacemen have secured of late for their products have been swallowed up by additional fuel costs.

Steel.

While there is a good inquiry for many classes of steel, the prices which rule more than cancel out any potential economies on an increased turnover. A fair amount of business is obtainable if the mills are prepared to fall in with buyers' ideas as to price. Such is the keenness of competition that business is being booked on terms which in many cases cannot conceivably show a profit. Steel orders are mostly restricted to miscellaneous constructional requirements, very few rails being wanted, and ship plates are seldom called for in any quantity. With additional mills in operation in the North, after long periods of idleness, competition even for small orders is keen, and has forced down values to such an extent that many steel works are debating whether it is worth while keeping their plant running. Some of them are inclined to let the business go by at present prices. Though the figure generally quoted this week for angles and joists is £7 2s. 6d., consumers state that they have no difficulty in getting supplies at as low as £7. Small rolled bars can be bought at £7 15s. for an attractive tonnage. Ship, bridge and tank plate and boiler plate values are irregular, the former ranging from £7 15s. to £8, and the latter from £10 17s. 6d. to £11. Staffordshire hoops command £10 10s. at works. Consumers of soft billets who last week withheld orders because they could not be placed at £6 have been able to get that price accepted this week, though sellers generally want half-a-crown more. Continental billets sell at about £5 6s. Business in steel scrap is not quite so good as it was, but values remain firm at £3 7s. 6d. delivered South Wales.

Manufactured Iron.

The South Staffordshire finished iron trade is very flat, and there are no new features. Business all round is quiet, but it is most marked in that section dealing with Crown and nut and bolt iron. The Staffordshire quotations are nominally 10s. per ton above those of Lancashire houses competing in the district, but in bargaining Black Country houses show more disposition to make concessions, on their published rates, where there is a prospect of good business being given out. The marked bar houses continue to find a fair demand from engineers, but the mills are only moderately busy. The basis rate of £14 10s. is maintained. The steel re-rolling mills are practically the only works having any bulk of orders on their books. They are, with the aid of cheap continental semis, securing a fair share of the available business, competing successfully with the large steel works.

Sheets.

Galvanised sheets are firm and the mills are well employed with orders ensuring activity into the New Year. The basis price for corrugated sheets of 24 gauge remains £16 12s. 6d., but in a large number of cases £16 15s. is obtained, and still higher prices are mentioned by firms well placed. Some good orders have come to hand for plain sheets required by makers of tanks and similar firms. The tin-plate trade is busier than for many months, and the scheme for the regulation of output, to come into operation in the New Year, is expected to improve prices.

Electrically Cut Coal.

A Cannock Chase colliery has just set up what is claimed as a record for the British coalfields in respect of the amount of coal electrically cut in a seven-hour shift. The pit is the old Hednesford mine of the Cannock Chase Colliery Company, Ltd., where all the coal raised is mined by electrical coal cutters. The record was set up by means of a Jeffrey 36-A Arcwall cutter, and in the shift of seven hours twenty-eight places were cut, 1739 yards flitted, each place being 15ft. wide and cut 6ft. under, and the total output of coal from the twenty-eight headings was 336 tons. The average time for each head was 15 min., and the average distance flitted was 62 yards per head. To have cut twenty-eight heads in seven hours is a remarkable achievement, and one which is, I understand, without parallel in the United Kingdom.

Suggested Fusion of Metallurgical Societies.

At the annual dinner of the Birmingham Metallurgical Society on Saturday last, the President intimated the possibility of the fusion of Midland metallurgical societies. Speaking of the existence in this area of similar bodies, he observed: "We rather feel there are too many metallurgical societies, and it is thought the time has arrived for the careful consideration of the question of the amalgamation of these various societies. There appears to be a consensus of opinion that amalgamation should take place as soon as possible. In my view, this is one of the most important things likely to come to pass in the future. By the fusion of the most prominent metallurgical societies in the Midlands a new body will arise which will have a very large membership. It will mean that the society will have a wider influence, and a greater capacity for carrying out the work we have in mind. We think that the advance of metallurgy in the Midlands is very largely bound up in the question of amalgamation."

The Late Mr. Isaac Lester.

A prominent figure has been lost to the iron trade of the Midlands and Staffordshire by the death of Mr. Isaac Lester, of Edgbaston, Birmingham. Mr. Lester was closely associated with the iron trade of the Midlands for many years, was an authority on foundry work, and had taken an active interest in research work. He was a native of Wednesbury, and obtained his scientific education at the Midland Institute, Birmingham, and the Royal School of Mines, London. For some years he was foundry manager at Kynoch's, Ltd., and produced the first casting for heavy shells made by that company. He spent five years in India laying down the first foundry at which the castings were produced for the first locomotive made in India. For the past seventeen years he was manager for Charles Akrill and Co., Ltd., of West Bromwich. He was a past-president of the Birmingham Metallurgical Society and the Staffordshire Iron and Steel Institute.

The Late Mr. W. H. Carder.

Another very well-known and highly respected member of Midland iron and steel circles died on November 27th in the person of Mr. W. H. Carder, of Tividale. Mr. Carder held secretarial positions which made him one of the best-known men in the industry. About twenty-three years ago he was appointed secretary of the South Staffordshire Mond Gas Company, Dudley Port, a position he retained until his death, and he succeeded the late Sir Gilbert Claughton as a director of the company. He was elected secretary of the Staffordshire Iron and Steel Institute as far back as 1881, and retained the office until about nine years ago. Mr. Carder took a keen interest in technical education and engineering progress, and was closely in touch with most of the associations in the country kindred to the one of which he was secretary for so many years.

Unemployment.

The slight increase in the number of unemployed in the Midlands recorded last week has now been adjusted. The latest total, 122,103, shows a marked improvement, being 4350 less than those given in the previous return, when the total was 126,453. In the Birmingham area the figures have fallen from 21,627 to 21,163, while at Coventry the decrease on the week is 211. The only towns in the area in which an increase was recorded were Derby, Redditch, West Bromwich and Worcester.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE markets all round for iron, steel and metals are rather quiet this week, and the amount of business passing seems inclined to fall off to a certain extent. It is a little early yet to feel the effect of the slackening of business which usually occurs as we approach the end of the year, but there seems to be a good deal of anxiety already felt in the trade in connection with possible labour troubles. There can be no doubt that the Government's method of dealing with the coal trouble last summer is causing a good deal of apprehension. It is scarcely conceivable that such a method can be renewed, and meanwhile practically nothing is being done to provide for the position when the subsidy comes to an end. The shadow of this trouble is already cast over the future of the iron and steel trades, and the fact that the reserve capital of those trades is being rapidly dissipated by sales at big losses is very ominous. Optimistic views as to the future seem sadly out of place when the difficulties in front of the industry are realised. No doubt the cheap steel now being sold at the expense of the steel trade and at much below cost has stimulated consumption to a certain extent, and so far is an advantage to shipbuilders, ship-repairers and engineers generally, but this advantage is gained at a terrible cost and of course cannot be permanent.

Metals.

The market for copper has been suffering from a setback lately, but it is not expected that this can last very long. There is a solid foundation for copper at the present prices, and it would seem to be a safe policy for the consumers to lay in moderate stocks while there is a favourable opportunity of doing so. Refined ingot copper, such as "Best Select," at £64 per ton, is a very safe proposition. In Manchester, of course, rather more than this has to be paid, but the local prices are moderate enough. The market seems to be temporarily affected by the state of the consumptive demand in Europe, for on the American side there is an increasing demand for industrial purposes. We are told of a trade boom coming in America, and, of course, there is a much better chance there for such a development than there is here. The slackening of the German demand for copper seems to be mainly the result of difficulties in connection with capital, and so soon as these are overcome it is reasonable to expect a considerable expansion in German buying. In France the vagaries of the Exchange interfere with the buying of copper, for it is feared that if something drastic is not done the franc may go the way of the mark. In the end, no doubt, European copper consumption is bound to recover; it is only a question of patience. Tin has moved rather irregularly, and in some quarters the persistence of the big backwardation is considered to be an unfavourable feature; but there are still quite a number of people here who expect to see the price at £300. There is however, just now an increase in the visible supply to be faced, and we may have an irregular market for a week or two. Lead has been rather weak, but there has been some slight recovery. Speculation as to the effect of larger arrivals from Australia makes the outlook rather uncertain, but any further fall in prices might stimulate consumption. Spelter has been a firm market, and most people here think well of it; but the price seems high enough.

Pig Iron.

The actual demand this week in the Manchester district for foundry iron is rather small, but this has not yet had much effect on sellers, who have secured, in most cases, sufficient work to enable them to look without anxiety on the cessation of fresh business. In one or two cases there may be incipient weakness, and, according to the reports of some merchants, it is occasionally possible to

obtain a small concession; but, as a rule, sellers of Derbyshire No. 3 foundry iron are firm at 73s. 6d. per ton delivered here, and sellers of Lincolnshire at 72s. 6d. That there should be a shrinkage in the volume of business is almost inevitable, because it is known that the actual increase in the consumption of foundry iron in Lancashire does not correspond with the increase in buying which occurred in October and the first fortnight in November. As a result there must, of course, be an increase in the stocks in founders' yards, or in the quantities to be received under contract. Sellers here seem fairly confident that when the "dead" period, which lasts from about the middle of December to the second week in January, is over, buying of pig iron will be resumed on a larger scale; and they seem to expect that prices will be higher then as a result of dearer furnace coke; and do not appear to be very willing to make sales far into the New Year unless at a premium. There is, however, no disposition on the part of buyers here to pay any premium for next year's deliveries, but rather the reverse. There is no Northamptonshire foundry iron being offered here now, as the price would be about 1s. 6d. per ton more than Derbyshire; but in the Birmingham district the Northampton ironmasters can and do compete with Staffordshire and Derbyshire. The Cleveland market was reported as rather optimistic about the future, but in Scotland there seems to be a weaker feeling, and sellers of Scotch iron in Manchester accept 94s. or perhaps a little less. The consumption of this class of foundry iron remains very much restricted by reason of the relative cost as compared with common iron and with East Coast hematite.

Steel.

There has no doubt been more actual business in finished steel in the Lancashire district during the last two or three weeks, as a direct consequence of the extremely low prices which have been accepted. There have been reports of sales of ordinary steel plates at £7 10s. per ton delivered, and angles at under £7, and with such cheap materials consumers have been able to secure more business; but, of course, the producers must be bearing a serious loss, for the very best equipped steel works cannot make plates and angles at such prices. Low prices for steel are, however, essential if work is not to be driven out of the country. The small reduction of 10s. in the price of steel boiler-plates does not satisfy the users of this material, who still complain that the difference between boiler and ship quality is absurdly great.

Scrap.

The market for scrap is rather better, and the demand seems to be on the increase here. Some dealers are paying up to 52s. 6d. for heavy steel melting scrap at a Lancashire station, and in Sheffield 62s. 6d. delivered has been paid. A slightly better demand for foundry scrap is also reported, but there is plenty of this available, and prices are about as before. For heavy wrought scrap there is a fair demand at 67s. 6d. per ton delivered to the Lancashire forges.

BARROW-IN-FURNESS.

Hematite.

The position in the North-West District hematite pig iron market shows slow improvement. There is no tendency to overrate the present position or to expect too much, but there are evidences of a better feeling. It is more than likely that in the early future there will be more furnaces in blast, not only in Furness, but Cumberland. Stocks at certain works are getting reduced, and as soon as they are within measurable distance of complete depletion there will have to be more output. The steel departments are taking a fair quantity of iron at Barrow and Workington. An increased demand for iron will probably result in a slight stiffening in price. Special qualities are in better demand and inquiries show a possibility of more business in the future. There is a fair inquiry from abroad for ferro-manganese.

Iron Ore.

The iron ore trade is in a better state than it has been for some months, and the prospects are fairly good in view of the possibility of more furnaces going in blast. There is a little more ore going out of the district and that trade may improve further. Foreign sorts are in better demand and imports are increasing.

Steel.

The steel trade is only fairly employed and the orders held are not heavy, but there is some chance of more contracts being secured in the district. The Barrow rail mills are working, as also are the hoop and small section mills.

Machinery.

Vickers have secured an order from the Admiralty for the machinery for the cruiser to be built at Devonport. This is very welcome and will in due course find work for a number of men in the boiler and machine shops. There is a better and more hopeful tone in the town regarding the future, and although it is too early to say anything at present of a definite character, one might commit oneself so far as to say that the New Year holds better prospects than was at one time thought possible. It is not likely that there will be any official news this side of Christmas, but next spring should see an improvement.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trades Quiet.

IN spite of the cheerful feeling which seems to pervade the Sheffield industries, it is difficult to find any actual evidence of improvement in the heavy iron and steel branches. About the same number of furnaces are operating, but in a few cases it is reported that less business is being booked than was the case some weeks ago. Of course, it must be borne in mind that all buyers of steel are now concentrating their attentions on keeping their stocks as low as possible for stocktaking purposes at the end of the year, and that, coupled with quiet trade generally in several important engineering branches, is keeping sales down to a rather disappointing level. Sellers of pig iron and steel are not averse from conceding a point or two in the matter of price if by so doing they can get business, and there is no doubt that work now being carried out will barely cover the cost of production, while some of it, in fact, will spell an actual loss. Definite evidence of the caution which has to be exercised in these days is forthcoming in company statements. A circular issued to the shareholders of John Brown and Co., Ltd., states that in view of the continued unsatisfactory condition of the steel, coal and shipbuilding industries, the directors do not consider it expedient on the present occasion to pay an interim dividend on the ordinary shares, but to await the results of the whole year's operations. The usual interim dividend on the preference shares will, however, be paid on December 22nd.

Engineering Departments.

The reference in the above circular to the state of the shipbuilding industry can be applied to a good many of the large steel firms of the city. There is a marked shortage of work from that source, and it means a big difference to Sheffield when big firms like Browns, Vickers and Cammell-Lairds, with shipbuilding yards, are unable to get the orders which will find employment in their Sheffield departments for the making of heavy forgings, castings and other steel parts. Some satisfaction, therefore, is felt in the city at the announcement that an order has been given for the building at Barrow by Messrs. Vickers of a set of plant and machinery for one of the new cruisers to be built in Government yards. This, it is definitely stated, will mean work for the River Don Works in Sheffield. Other contracts, which have been expected almost daily for some time may be quickly following. Railway engineering work is rather quieter, though a fair amount of business would appear to be in prospect early in the New Year. Work of any kind is very difficult to get from collieries, for the long-continued depressed conditions in the coal trade are telling their tale in an unmistakeable manner. Collieries cannot afford in these days, and with prospects so uncertain, to spend a penny more than is necessary, and in colliery machinery generally, and particularly in wagons, there is a scarcity of orders. In the lighter engineering departments business is passing more freely, though conditions are variable. Steel and magnets for the motor trade are being produced in large quantities. Bristol Corporation's £1,000,000 electricity extension scheme has been placed with Vickers Ltd., in conjunction with Metropolitan-Vickers Electrical Company, Ltd., subject to the approval of the Electricity Commissioners.

Future of Special Steels.

Mr. R. Armitage, chairman and managing director of Brown Bayleys Steel Works, Ltd., made an interesting reference to the manufacture of special steels at the annual meeting of the company in Sheffield. Things were still difficult in the steel trade, he said. Railway material work had been severely depressed, but they had been developing other branches in the special steel trade, which was largely due to the work of Mr. H. Brearley, who is a member of their staff. They hoped that that would help them more in the future, because there was every sign that the special steels required in this country were going to increase in consumption. The high railway rates and the difficulties on the railways were sending more and more people to the use of motor lorries for road work, and as all those vehicles must have special steels, they hoped that what they lost on one side they would more than gain on the other. He added that they had a somewhat long road before them, because when new steels and special steels were introduced, people did not jump at them all at once. He hoped in the years to come they would see the fruits of the work that was now being done. In that connection, it is interesting to note that the Weldless Steel Tube Company has begun the manufacture on a commercial scale of cold-drawn stainless tubes from steel supplied by Brown Bayleys. These tubes, it is claimed, are unaffected by weather or ordinary industrial conditions, are resistant to alkalis, salt solutions, fruit juices and nitric acid, and are not attacked by ammonia fumes, ammoniacal liquor, picric acid or nitric compounds.

Plate and Cutlery.

The falling off in the seasonal trade in cutlery and plate to which I referred last week has now been made worse by several orders being cancelled. Shopkeepers decline to go in for extensive stocking, particularly of the highest quality goods, and as there is now such a short time to the holidays, the season looks like closing in most disappointing fashion. Business now being done is mainly of a casual nature, and the busiest departments are those producing the cheaper class of plate and cutlery. Although large quantities of stainless knives are being produced, the output has had to be curtailed. Other cutlery lines are quiet, with the exception of safety razor blades, which are finding a demand that is steadily increasing. Some attention has been directed of late to the question of apprentices in the lighter trades of Sheffield, and the suggestion has been made that a conference of those interested should be called. There are certainly many vital points that could be discussed profitably.

Mining Subsidence Problems.

A review of the question of mining subsidence in the area between Doncaster and the Trent was given by Major G. H. Peake, the chairman, at the annual meeting of the Hatfield Chase Drainage Commissioners. He said that the problem was how to act in the best interests of agriculture, coal mining, and possibly navigation, now that it was probable that coal would be worked under the whole area, and that subsidence of the surface must take place. He was certain that to go back to the old natural outfall of the river Don into the river Trent would be sound policy, providing the cost was not too much and that arrangements could be made for coupling up with the Sheffield and South Yorkshire Canal. It was possible that such a new outfall might provide for navigation as well as drainage. As collieries were developed the coal must be transported, and the traffic on such navigation might pay interest on a large part of the cost. Another matter of colliery interest to note this week is the new record in coal getting set up by Askern Colliery, Doncaster. The record week's output of 8200 tons has been reached, an increase of 300 tons over the previous best tonnage.

Trams and Telephones.

Two items of trade interest come from Hull. The Tramways Committee has placed a contract for steel rails with Bolckow, Vaughan and Co., Middlesbrough, and the Corporation Telephones Committee has accepted two tenders for German-made cable and wire; £368 13s. 4d. was quoted for a supply of Germon bronze wire, against £414 1s., which was the lowest British tender.

Vickers' Director Resigns.

Mr. William Clark, managing director of Vickers Ltd., River Don Works, Sheffield, has announced his intention of resigning at the end of this year. He came to Sheffield from Scotland in 1911, has been Master Cutler, President of the Chamber of Commerce, and has in other ways played a prominent part in the industrial life of the city. Mr. Clark during the war was called upon to control and direct a great number of alterations, extensions and developments in connection with the manufacture of armaments and munitions. He was closely in touch with the Government and gave much valuable help for speeding up the supply of shells.

NORTH OF ENGLAND.

(From our own Correspondent.)

Coal Losses Soaring.

A HEAVY drop in the economic yield of coal in Northumberland and Durham is revealed in the joint reports of the accountants with respect to the proceeds and costs in the coal-mining industry for the months of August, September and October. In the county of Durham the miners' wages under the subvention scheme will continue in December at the minimum level of 110 per cent., whereas the ascertainment shows that the report on proceeds and costs would have given them only 37·90 per cent., as compared with 47·96 per cent. in November, a reduction of 10·06 per cent. The Northumberland result is slightly worse than that of Durham. In December the percentage on basis rates would have been 24·53 per cent., as compared with 35·49 per cent. in November, a reduction of 10·96 per cent. The minimum in Northumberland is 100 per cent. The Durham miners will therefore receive in December in percentage on the basis wage 72·10 per cent. more than the sale of the coal has yielded, and the Northumberland miners 75·45 per cent.

Iron and Steel Exports.

Although the November shipments of pig iron, manufactured iron and steel from the Cleveland district have fallen short of those for the preceding month, the aggregate of 85,667 tons is rather higher than the average monthly shipments this year, and the total would certainly have been still higher but for the bad weather. The storms have wrought havoc amongst shipping, and so many boats have been delayed that shipments have fallen into arrears, hence November's modest showing. Still, it is a fact that foreign shipments of pig iron during November have exceeded 20,000 tons for the first time this year, thanks chiefly to the very heavy shipments to Italy and to Belgium. No doubt the Charleroi strike has increased the call for Cleveland iron at Antwerp, but there is evidence in all the European markets of a slightly better demand for British pig iron. Italy took 4540 tons of pig iron, Belgium 4507 tons, the United States 2980 tons, France 1980 tons, Denmark 1409 tons, Germany 1330 tons, Sweden 1284 tons, and Finland 1125 tons. India continues to be Cleveland's best customer for steel and the trade in that direction has been well maintained, the exports last month totalling 13,871 tons. Less steel, however, has been shipped to the South American Republics, and chiefly on that account the total exports of manufactured iron and steel have fallen from 66,278 tons to 52,344 tons. The Cape of Good Hope received 7583 tons, and Egypt 2203 tons.

Cleveland Iron Trade.

The outstanding feature in Cleveland iron trade circles this week has been the action of the makers in once more resorting to a system of fixed prices. It was not unexpected. For some time past there has been a feeling that the undercutting of prices which was going on amongst makers was inimical to the best interests of the trade, and under the pressure of rising fuel costs they have decided to fix minimum prices below which they are all pledged not to sell. For a time there may be a little undercutting by second-hands, but from now on it is agreed that the minimum prices for Cleveland iron for home sale shall be:—No. 1, 68s. 6d.; No. 3 G.M.B., 66s. 6d.; No. 4 foundry, 65s. 6d.; No. 4 forge, 64s. 6d. For export a premium of 6d. per ton is to be added, due to the extra cost of putting iron f.o.b. On this ground it may be justified, but merchants in the export trade are frankly apprehensive of the effect of even this small increase in price upon the export trade. Already it is difficult to procure export orders, owing to the relative cheapness of continental iron, and this risk, of course, increases the handicap to British trade. In the home trade the position is different. It is true that iron is still being imported from abroad, but for the most part home consumers are dependent upon home sources of supply, and they will, no doubt, have to follow the rise.

Hematite Pig Iron.

In the East Coast hematite pig iron trade there is a temporary shortage of supplies, but this should soon

be overcome by the extra production of two more furnaces which are being put into operation. Meanwhile, prompt supplies are difficult to obtain, and some makers have no iron to sell. Mixed numbers are quoted at 75s., and No. 1 at 75s. 6d. per ton.

Ironmaking Materials.

There is a little more business passing in foreign ore, chiefly for small cargoes, but forward contracts are hardly heard of nowadays. Best Rubio ore is firm at 20s. 6d. per ton, c.i.f. Tees. Good Durham furnace coke is now quoted up to 21s. per ton delivered at the works.

Manufactured Iron and Steel.

The outlook in the manufactured iron and steel trade is brightening. Business is expanding in many directions, and all the works are more actively employed. This week Bolckow, Vaughan and Co., Ltd., Middlesbrough, have obtained an order for 23,000 tons of steel rails for the Egyptian State Railways, in face of keen continental and American competition. In addition, the firm has received an order for 80 per cent. of the material required for the six new vessels being built on the river Wear for the Silver Line, and also for the material for another large vessel to be built on the Tyne. Steel prices are unaltered.

The Coal Trade.

The Northern coal trade presents few new features of moment this week. The long spell of wintry weather and the consequent delay in the arrival of shipping has had the effect of causing considerable dislocation and inconveneince at the coaling staiths. Operations at the collieries have also been affected. The small demand and the continued irregularity of prompt stems are factors towards an easier market for Northumberland steam coals. There are now good prompt supplies of best qualities held by contractors, which can be obtained at the lower basis of 15s. per ton, while more forward lots are only worth about 15s. 3d. per ton. Tenders have been invited by the Swedish State Railways for the supply of 32,000 tons of steam coals for delivery up to the end of March next year. There is sure to be keen competition for the order, and a new factor in that respect is Silesia, now a strong rival to British coals in Scandinavia. Silesia has a surplus of fuel, and can sell cheaply, shipping through the port of Danzig. Though rather quiet, the steam smalls market is maintained, owing to the restricted supplies, and bests remain at 9s. 6d., seconds at 8s. 6d., and specials around 9s. 9d. The Durham market appears to remain generally firm, with few parcels of coal offered. The colliery positions are tolerably good under recent bookings. Best qualities of gas coals are unchanged at 16s. to 16s. 6d., and up to 16s. 9d. is asked for specials. Seconds are in some demand, but being scarce, business is rather slow. Prices, however, are strong at 15s. to 15s. 6d. Coking coals are a steady trade at full and slightly firmer prices, quotations ranging from 15s. to 15s. 6d. No new feature is shown for coke, and recent figures are indicated.

SCOTLAND.

(From our own Correspondent.)

Decline in Shipbuilding.

THE amount of new tonnage launched from Clyde yards during the month of November was comparatively small, the returns indicating ten vessels of 21,509 tons aggregate. The aggregate tonnage for this year to date is over 24,000 tons below the figures for the corresponding period of last year. The work in progress is small, and at present there is not a single liner and very few mercantile vessels on the stocks. Only three vessels of 5000 tons and over were launched during November, as follows:—Perla, passenger and cargo steamer, 5900 tons, built for the Navigazione Liberia Triestina, Trieste; Benarty, 5850 tons, for the Ben Line, Leith; Marthara, 5000 tons, for Maclay and M'Intyre, Glasgow. A number of contracts have been reported during last month, but it is still considered that the business secured is insufficient to cause much improvement in the trade generally. Costs of construction still militate against the building of new tonnage on anything approaching a satisfactory scale, and the immediate outlook is not encouraging. New contracts include the machinery for one of the new cruisers which are being built in the Royal Dockyards; a motor vessel of 15,000 tons for Alfred Holt and Co., Liverpool; an oil-tanker of 12,000 tons carrying capacity for the Vacuum Oil Company; and a cargo vessel of 7800 tons for the Anchor-Brocklebank Line.

Steel.

The situation in the steel trade still leaves ample room for improvement. The demand for shipbuilding material is far below expectation, and it is hoped that the reduction of 10s. per ton in the price of boiler-plates may help to stimulate matters. Makers are now quoting £11 per ton for boiler-plates, home or export delivery. Ship-plates and sectional steel are very disappointing. Makers of sheets continue to report a regular flow of orders for thin gauges. Galvanised sheets are especially busy and firm in price owing to the high cost of spelter.

Iron.

The amount of business in the iron market is still most disappointing, owing, in a measure, to home as well as foreign competition. Re-rolled steel bars remain in moderate demand, but the prices obtainable are not particularly remunerative.

Pig Iron.

The pig iron market has a dull aspect. Prices are fairly steady at present levels, but the amount of business passing is of a small hand-to-mouth description.

Coal.

The demand for coal has not been particularly active recently, especially for export. The collieries have been busy overtaking the arrears of orders occasioned by the foggy weather and delays to vessels held up by storm. Bookings are comparatively good at the moment, despite the drop in demand, and Lanarkshire and Fifeshire fuels move off with regularity. Ells, splints, Fifeshire steams and washed nuts in both districts are all firm in price. Collieries in the Lothians experience a drop in demand owing to the industrial dispute in the district. Washed materials and double nuts in particular are most affected. Aggregate shipments amounted to 259,078 tons, against 205,649 tons in the perceding week, and 263,898 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE has not been a great deal of change in the general state of the steam coal trade since I wrote a week ago. The conditions are if anything rather quieter, that is, so far as new business for early loading is concerned. Chartering operations have also not been quite so active, and while most of the collieries are fairly well engaged and working pretty regularly, the tone of the market has not further improved on the whole. This applies more particularly to large coals, as smalls have certainly advanced owing to supplies being unequal to the demand. It was, however, thought at one time that values would have shown an all-round improvement in view of the fact that December is a short working month, and the fact that there appears to be somewhat of a lull in the market is a little disappointing. Rumours were current last week-end that a big expansion in the demand for coals for shipment to America was probable, as reports were received that the strike of anthracite miners in America was likely to extend to the soft coal miners. It was argued that in this event there would be a substantial inquiry for steam coals from this district, but the rumours which were about have subsequently found no confirmation, and, on the contrary, it appears that it is by no means unlikely that there may be a settlement before the end of December of the strike of the anthracite miners. Apart from that, interest on this market has centred chiefly in the tenders which have been sent for the Egyptian State Railways' order for about 200,000 tons of steam coals from this district. Prices had to be in on the 2nd inst., but it may be a week before anything is known as to the definite placing of the business. It is reported, however, that prices which have gone in range about 30s. c.i.f. Alexandria, this being for leading Monmouthshire black vein and Cardiff large coals suitable for locomotive purposes. The Great Southern Railway of Ireland is understood to have placed orders for a fair quantity of locomotive coal for delivery over the first few months of next year, and the Great Northern Railway of Ireland has asked for tenders for 50,000 tons of locomotive coal over the first six months of 1926, or 100,000 tons over the whole of the next twelve months. Tenders have to be deposited in Dublin on the 10th inst.

Anthracite Colliery Deal.

The announcement is made that the Ashburnham Steamship and Coal Shipping Company has acquired the Trimsaran Colliery near Llanelly, belonging to a company in which Mr. Evan Jones, of Llanelly, has a controlling interest. This undertaking has an output of about 400 tons per day, but is capable of substantial development.

Shipments at Swansea.

Complaints have long been prevalent regarding the shipping facilities at Swansea. The demand for anthracite has in the last year or so increased considerably, but the facilities for shipment have not kept pace with it, and a very considerable amount of coal which in the ordinary course would have been shipped at Swansea has been transferred for loading at Port Talbot. There is, however, much room for improvement all round. The traders in the Swansea area have been alive to the importance of securing better facilities, and at a recent meeting of the Swansea Chamber of Commerce the acceptance of certain regulations arranged between the Chamber's special committee and the Great Western Railway Company governing the stemming and allocation of coal-shipping appliances at the Swansea Docks was recommended. At the same time it was stated that although during the past six weeks they had exported 455,000 tons of coal at the Swansea Docks, or an average of 4,000,000 tons per annum, they could easily ship another 33⅓ per cent. if the Great Western Railway Company would give them the facilities which it promised when it took over the docks. It was pointed out that the great need was for proper modern sidings. The Chamber decided that its "Mergo" Committee should make strong representations to the company on the whole matter.

Tin-plate Industry.

The claim of the tinmen for a 15 per cent. advance came before a meeting of the Joint Standing Committee of the Tin-plate Industry last week, but after discussion the matter was referred back to the sub-committee for further consideration. In order to expedite the settlement of questions arising the men's representatives suggested monthly meetings of the Committee, but eventually the proposal of the employers to have meetings every two months was adopted. The Cilfrew Tin-plate Works, belonging to Richard Thomas and Co., which have been closed since April re-opened this week with two mills employing about sixty men. This is to be followed by the remaining two mills restarting as soon as circumstances permit.

Boilermakers and Ship-repairing.

Reference was made last week to the resumption of work by the boilermakers employed in the ship-repairing industry of this district. No announcement has been issued regarding any agreement come to concerning the methods adopted for taking men on for work at the various yards, though a change has been made which affords more satisfaction to the men and gives the general body of workers more opportunity for employment instead of a comparatively few getting prior consideration.

Engineering Exhibition at Cardiff.

Another engineering exhibition organised by the South Wales Institute of Engineers is now being held at Cardiff, and is proving a great success from the point of view of the promoters and exhibitors. The exhibition was officially opened on Thursday of last week and closes on the 5th. In the absence of the Earl of Plymouth the exhibition was formally opened by the president of the Institute—Mr. H. Spence Thomas—who was accompanied by Sir W. J. Larke, K.B.E., director of the National Federation of Iron and Steel Manufacturers, Westminster. The arrangements for the display of the exhibits were better than on any previous occasion. There are altogether about fifty stalls, and manufacturers from all parts of the country are represented, while local undertakings are well to the fore. The fact that fully 80 per cent. of the exhibitors at previous exhibitions are again showing their productions points to the value placed by them upon being represented. The organisers have aimed, as far as possible, in encouraging exhibitors to provide something new to promote interest in the undertaking, and in that they have succeeded. Furthermore, the exhibition is more on the mechanical than the electrical side on this occasion. The most modern coal cutters are a special feature, as are haulage agencies, in addition to which there is a very comprehensive show of steam-raising and steam utilisation plant. Saturday last was regarded largely as the experts' day, inasmuch as the exhibition was visited by members of the South Wales branch of the National Association of Colliery Managers and that of the Association of Mining Electrical Engineers.

Coalfield Items.

The report is current that negotiations are afoot for the amalgamation of the Copper pit, the Pentre and the Mynydd Newydd collieries, all of which are in close proximity with Swansea. This amalgamation, if effected, would mean improved working advantages and a joint output of 1000 tons per day. The Norths Navigation Company has decided to re-start its Caerau colliery, which employs 2300 men. This colliery stopped working a month ago on account of trade depression.

Current Business.

The demand for steam coals for early loading has not been quite so active during the past week, though the tone is well maintained. Prices of large qualities have not undergone any change, but smalls are distinctly firmer, especially the superior grades, which now rule up to 13s., and are almost unobtainable as they are so scarce. In the case of large descriptions, best Admiralties are steady and are fairly well stemmed, but second qualities and Monmouthshires are in some instances none too well placed for orders. Patent fuel is unaltered and coke is in fair demand, while pitwood is firm. Anthracite coals are slightly irregular in the case of large coals, but sized qualities are well maintained.

CONTRACTS.

THE Wanganui Harbour Board (New Zealand) has placed an order for the construction of a twin-screw fire and salvage tug with the Dublin Dockyard Company (Vickers-Ireland, Ltd.). The vessel's dimensions are to be 110ft. by 24ft. by 12ft., and the machinery will consist of two sets of triple-expansion engines developing 800 indicated horse-power. This is the second order placed with the firm by New Zealand Harbour Boards during the last month.

THE Engineering Department of Edgar Allen and Co., Ltd., in addition to the orders which it received some time ago for the erection of cement plant for the Sulphide Corporation, Ltd., Cockle Creek, Australia, the Gillingham Portland Cement Company. Ltd., Gillingham, Kent, and the Dunstable Portland Cement Company, Ltd., Dunstable, Bedfordshire, has within the last few months received the following additional orders:—(*a*) From the Barnstone Cement Company, Ltd., Barnstone, near Nottingham, for the whole of the cement manufacturing plant and the electrical equipment of a new cement works which that company is about to erect; the first unit will have a capacity of 30,000 tons of cement per annum, and the plant will be designed for an ultimate capacity of 60,000 tons; (*b*) from Joseph Crosfield and Sons, Ltd., Warrington, England, for two rotary kilns for lime burning, together with special equipment for extracting the dust from the flue gases; the kilns will be fired by means of producer gas; and for a rotary sand drying plant; (*c*) from the Standard Portland Cement Company, Ltd., New South Wales, Australia, for the second unit of the 100,000-ton cement manufacturing plant for which the firm received the main contract some few months ago. This contract was obtained against strong foreign competition; and (*d*) from the Sulphide Corporation, Ltd., London, for a second 30,000-ton per annum cement making unit for the Sulphide Corporation's factory at Cockle Creek, New South Wales, to supplement the first unit, which was put into operation in April last.

THE INSTITUTION OF MECHANICAL ENGINEERS: AWARDS.

THE Council of the Institution of Mechanical Engineers has awarded the following prizes for papers read before Graduates' Sections during the session 1924–25:—

"Pulverised Coal," by K. C. Barrell, M.A. (Graduate), £5; read before the Graduates' Section, Midland Branch.

"Recent Developments in Solid Injection Oil Engines," by K. Rowell, B.Sc. (Graduate), £4; read before the Graduates' Section, London.

"The Reduction of Factory Costs," by E. H. Lewis, M.Sc. (Graduate), £4; read before the Graduates' Section, North-Western Branch.

"Involute Gearing," by F. W. L. Heathcote, B.Sc. (Graduate), £3; read before the Graduates' Section, North-Western Branch.

"The Erection of Steam Turbine Plants on Site," by J. B. Cushny, B.Sc. (Graduate), £1; read before the Graduates' Section, North-Western Branch.

The Council further decided that an abstract of Mr. Barrell's paper on "Pulverised Coal" should be published in the "Proceedings" of the Institution.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	21/-
(1) Spanish	18/6
(1) N. African	18/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	20/6

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) SCOTLAND—		
Hematite	3 18 6	—
No. 1 Foundry	4 0 0 to 4 2 6	
No. 3 Foundry	3 17 6 to 4 0 0	
N.E. COAST—		
Hematite Mixed Nos.	3 15 0	3 15 0
No. 1	3 15 6	3 15 6
Cleveland—		
No. 1	3 8 6	3 9 0
Silicious Iron	3 8 6	3 9 0
No. 3 G.M.B	3 6 6	3 6 6
No. 4 Foundry	3 5 6	3 6 0
No. 4 Forge	3 4 6	3 5 0
Mottled	—	—
White	—	—
MIDLANDS—		
(2) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(2) Northampton—		
Foundry No. 3	3 2 0	—
,, Forge	2 16 0	—
(2) Derbyshire—		
No. 3 Foundry	3 5 0 to 3 6 0	
Forge	3 2 0	—
(2) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 6 0 (a); 4 8 6 (b); 4 12 6 (c)	— — —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 5 0	—
Best ,,	—	—
N.E. COAST—		
Common Bars	11 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	11 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(b) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up.	7 15 0	—
Sections	7 7 6 to 7 10 0	
Steel Sheets, under 3/16in. to ¼in.	9 5 0 to 9 7 6	
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	7 5 0	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light ,,	8 5 0 to 8 10 0	
Billets	7 10 0 to 10 10 0†	
MANCHESTER—		
Bars (Round)	8 5 0 to 9 0 0	
,, (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	8 0 0 to 8 5 0	
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet-bars	6 0 0 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 12 6 to 16 15 0	
Angles	7 2 6 to 7 7 6	
Joists	7 2 6 to 7 7 6	
Tees	8 2 6 to 8 7 6	
Bridge and Tank Plates	7 15 0 to 8 0 0	
Boiler Plates	11 0 0 to 12 0 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/9 to 20/3
Block Tin (cash)	288 0 0
,, (three months)	282 7 6
Copper (cash)	60 0 0
,, (three months)	61 0 0
Spanish Lead (cash)	35 3 9
,, (three months)	34 12 6
Spelter (cash)	38 15 0
,, (three months)	37 12 6
MANCHESTER—	
Copper, Best Selected Ingots	65 10 0
,, Electrolytic	67 10 0
,, Strong Sheets	92 0 0
,, Tubes (Basis Price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
,, Condenser	0 1 2½
Lead, English	37 0 0
,, Foreign	36 0 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/8 to 1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 0 0	7/9
,, 8 p.c. to 10 p.c. ,,	£22 10 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£40 0 0	15/-
,, ,, 1 p.c. ,,	£51 0 0	17/-
,, ,, 0.70 p.c. carbon	£56 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	3/9 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£21 0 0 scale 6/- per unit	
,, Vanadium	15/9 per lb.	
,, Molybdenum	6/- per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£172 to £177	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Inland.	Export.
LANARKSHIRE—		
(f.o.b. Glasgow)—Steam		14/9
,, ,, Ell		15/4½
,, ,, Splint		16/6 to 18/3
,, ,, Trebles		17/3
,, ,, Doubles		16/6
,, ,, Singles		14/3
AYRSHIRE—		
(f.o.b. Ports)—Steam		14/9
,, ,, Splints		16/6
,, ,, Trebles		17/3
FIFESHIRE—		
(f.o.b. Methil or Burntisland)—Steam		12/6 to 15/-
Screened Navigation		20/9
Trebles		18/- to 19/-
Doubles		16/6
Singles		14/6
LOTHIANS—		
(f.o.b. Leith)—Best Steam		14/10½
Secondary Steam		14/3
Trebles		17/9
Doubles		16/3
Singles		14/6

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		23/6
Household		40/- to 45/-
Coke		26/-
NORTHUMBERLAND—		
Best Steams		15/6
Second Steams		14/6
Steam Smalls		10/- to 10/3
Unscreened		14/-
Household		20/- to 22/-
DURHAM—		
Best Gas		16/- to 16/6
Second		14/6 to 15/-
Household		20/- to 22/-
Foundry Coke		20/- to 22/6
SHEFFIELD—	Inland.	
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	24/- to 26/6	—
,, ,, House	23/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	16 6 to 19/6	—
Derbyshire ,,	16/- to 19/-	—
Rough Slacks	9/6 to 12/6	—
Nutty ,,	6/- to 7/6	—
Smalls	3/6 to 5/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	17/9 to 18 3

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	23/- to 23/6
Second ,, ,,	21/- to 22/6
Best Dry Large	22/6 to 24/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	20/- to 21/6
Western Valley ,,	19/- to 20/-
Best Eastern Valley Large	19/- to 19/6
Ordinary ,, ,,	18/9 to 19/-
Best Steam Smalls	12/- to 13/-
Ordinary ,,	10/- to 11/6
Washed Nuts	19/- to 20/6
No. 3 Rhondda Large	26/- to 26/6
,, ,, Smalls	14/6 to 15/-
No. 2 ,, Large	19/- to 19/6
,, ,, Through	16/6 to 17/6
,, ,, Smalls	10/- to 10/6
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/6 to 22/6
Pitwood (ex ship)	31/- to 31/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	38/- to 42/-
Seconds	32/6 to 37/6
Red Vein	28/- to 32/-
Machine-made Cobbles	57/6 to 60/-
Nuts	57/6 to 60/-
Beans	42/- to 43/6
Peas	21/- to 25/-
Breaker Duff	6/9 to 7/6
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	22/- to 23/6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/6 to 17/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/6, with fluctuations according to analysis; open market, 17/- to 18/6 at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Iron and Steel Agreements.

THE negotiations that have been carried out for an international agreement amongst iron and steel firms whereby each country will be allotted a certain proportion of the work available in foreign markets have so far failed on account, it is said, of the specially favourable situation of countries with a depreciated currency, which are able, with the low prices they quote in those markets, to put forward what are regarded as exaggerated claims. This is the German explanation of the breakdown of the negotiations with French iron and steel makers, who are alleged to have insisted on Germany taking a quota of material from France which would have reduced the German production to 60 per cent. of its present figure. Under these circumstances German iron and steel producers prefer to postpone further negotiations in the hope that the situation will so far improve as to place the two countries on terms of equality so far as selling prices are concerned, but the events of the past few weeks, by widening the margin in money values, has rendered the solution still more difficult, in the sense that the rapid depreciation of the franc has, for the time being, increased considerably the facilities for selling French iron and steel in foreign markets. Heavy speculative buying has enabled French mill and forge owners to sell forward their production for some time to come, and they will doubtless continue to do so so long as the franc pursues a downward course. The danger to the French lies in a rapid recovery, which might take place in the event of the financial difficulties being adjusted, and until then the Germans are quite prepared to wait. Meanwhile the only international agreement that has been carried out is the one relating to rails.

Engineering Contracts.

The situation of engineering firms is rendered particularly unsatisfactory by the monetary stringency which has suspended nearly all the big undertakings, and there is very little hope of their being put in hand until money can be raised by foreign loans. Any prospect of it being done depends upon the turn events will take in the early future. As soon as the various schemes are started upon there will be plenty of work for everyone. Until then it is feared that the situation can hardly improve, and in some departments, such as wagon building, it cannot fail to become worse. The railway companies are certainly anxious to give out orders for rolling stock, but can hardly do so for another two or three months at least. Meanwhile wagon builders are doing scarcely anything at all, and the only order of importance is one for wagons for colonial railways. In all cases the question of credits is a serious matter, and some of the big engineering concerns which have been fairly busy, largely on the execution of foreign contracts, find their financial resources considerably diminished by the huge credits they are obliged to allow abroad. At home, commercial credits are obtainable with difficulty, while financial credits are out of the question. One firm is expecting to secure an order for a bridge at Constantinople to replace one constructed by the Germans before the war. The Colonies will also be providing some good contracts as soon as the financial situation permits of the necessary funds being raised.

Road Materials.

The experiments that have been carried out with different road-making materials in Paris during the past year have already provided interesting data concerning the advantages or otherwise of the various systems of road construction employed. Special prominence is given to asphalt on account of the strictures of the late Prefect of the Seine, who declared that it was responsible for too many motor car accidents in damp weather, and the Municipal Council seeks to show that there is no reason to suppress a form of construction which possesses advantages from the point of view of cost and maintenance. It is impossible to declare that any one material is better than another, for each may be specially suitable for particular thoroughfares according to the gradient, situation, width, and nature of traffic. In the case of asphalt it is declared that there are many streets in which it can be employed satisfactorily, and it is hoped to extend its use with the aid of some rubber non-skidding material. Meanwhile, the results obtained with other materials, such as asphalt blocks, concrete, bituminous concrete and cement lead to the belief that they may prove suitable under certain conditions, and a report is to be prepared upon the character and traffic conditions of each street in Paris with a view of selecting the best material for paving. In the coming year experiments will be carried out with various kinds of brick paving, although it is believed that it can only be suitable for motor traffic.

Railway Rates.

In view of the increasing deficits of the railway companies, the Conseil Supérieur des Chemins de Fer has approved of a proposal to advance still further the railway rates, both for passengers and goods, and it is intended to provide a progressive scale of increases according to the value of goods carried. Since the rates were last raised there has been a steady diminution of traffic, and it is argued that the decline will be accentuated by any further increase in freights. Nevertheless, there appears to be no other way out of the difficulty, especially in view of the steadily advancing charges and the claims of all grades of railwaymen and employees for a further advance in wages.

Aviation Engines.

The trials of aviation engines, organised by the Sous-Secrétariat de l'Aéronautique, for which prizes amounting to 2,000,000f. were offered, have just been concluded after being in progress for nearly eighteen months. The tests were of a particularly arduous character and were confined to engines of from 350 to 450 horse-power and weighing not more than 3 kilos. 300 per horse-power, including fuel and oil for a flight of five hours. Of the thirteen engines entered only eight competed and four completed the trials satisfactorily—two Renault engines, a Lorraine, and a Panhard.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

241,490. July 17th, 1924.—REGENERATIVE ENGINES, M. Martinka, Rákosszentmihály, near Budapest, Hungary.

The inventor proposes to utilise the heat of the exhaust gases of an internal combustion engine for preheating the combustible charges. He points out that the best conditions for regeneration arise when the quantity of hot gases flowing through the re-

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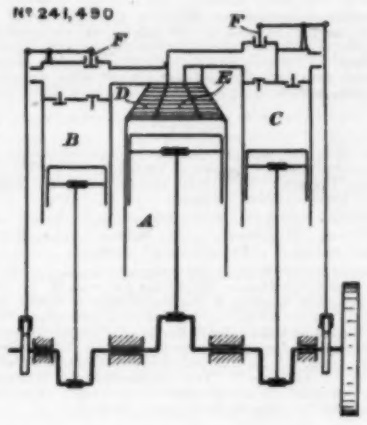

generator equals that of the incoming gases to be heated. The engine comprises a working cylinder A, an air pump B, and a gas pump C. The air is forced into the cylinder through the regenerator D and the gas through the separate regenerator E. The exhaust takes place through the two valves F F, which are so controlled that the flow through the two regenerators is equal in both directions.—*October 19th*, 1925.

241,494. June 17th, 1925.—FUEL INJECTION LEVICES, *J. J. V. Armstrong*, 12, *Church-street, Liverpool.*

According to this invention several spring-controlled needle valves are arranged in one and the same chamber adjacent to the combustion chamber and are adapted to come into operation

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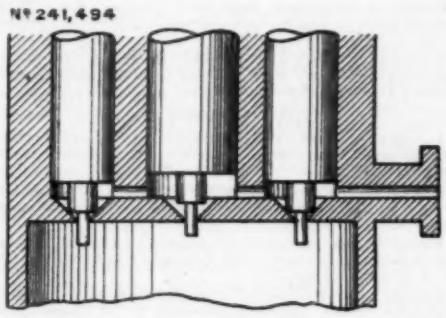

in a fixed order from light running to full load, according to the pressure of the fuel pump. The operation of the separate needle valves in the desired order is effected by suitable choice of the cross section exposed to the pressure of the liquid, whilst the counter force acting to close the valves is formed by springs acting on the upper parts of the needles.—*October 22nd*, 1925.

TRANSFORMERS AND CONVERTERS.

241,376. October 4th, 1924.—IMPROVEMENTS IN ELECTRIC TRANSFORMERS, Stanley Austin Stegant, of 33, St. John's Park, Blackheath, S.E. 3; Albert Edward Holliman, of 58, Charlton-lane, S.E. 7; and Johnson and Phillips, Ltd., of Victoria Works, Charlton, S.E. 7.

This specification describes an improved method of compen-

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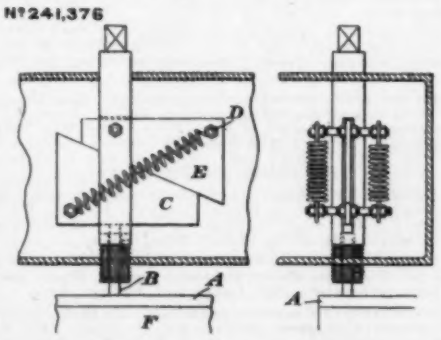

sating the shrinkage of the insulation of transformer coils under normal working conditions. An approximately constant pressure is applied to a damping ring A by rods B engaging with the ring and actuated by the sliding movement of wedge-shaped members C coupled together by springs as shown. The upper end of each spring is secured by a bolt D to the wedge E and the lower end to the wedge C. If the insulation of the coils F shrinks the wedge C is urged to the right by the springs and causes the rod C to descend and transmit an approximate constant pressure to the ring A. It will be understood that the wedges are fitted in a slot in the upper part of the rod and that the lower wedge C is free to move.—*October 22nd*, 1925.

TELEGRAPHS AND TELEPHONES.

241,050. December 20th, 1924.—IMPROVEMENTS IN ELECTRON DISCHARGE DEVICES, The Western Electric Company, of Connaught House, Aldwych, W.C. 2.

The object of this invention is to cool the anode of a thermionic valve and simultaneously to insulate it from earth and the associated apparatus. The supporting structure A consists of a

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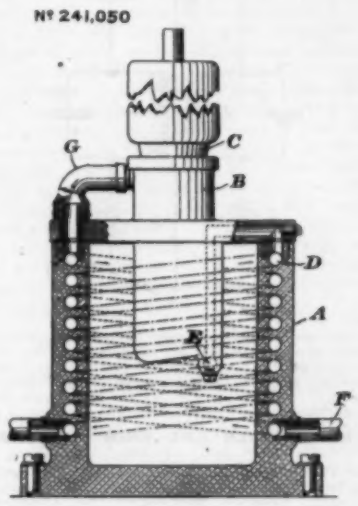

cylinder composed of moulded insulation. A metallic water jacket B surrounds the anode C. The cooling water from the supply F circulates through the pipes as indicated by the arrows and enters the water jacket of the anode at E. An insulated joint is provided at G. The wall of the frame A serves for radiating the heat imparted to the water by the anode.—*October 15th*, 1925.

220,608. July 19th, 1924.—IMPROVED ARRANGEMENTS FOR INCREASING THE FREQUENCY OF ELECTRIC CURRENTS, Marcel Lucien Touly, of 27, rue de Courcelles, Paris, Seine.

A mercury vapour valve has two anodes A and B and two grids C and D. There is also a cathode at E. A single-phase generator F is connected to the anodes through an auto-transformer G. The cathode E is connected to the middle point of the transformer by means of an oscillatory circuit consisting of an inductance H, a capacity I, and a load K J. This tuned circuit may represent a wireless aerial, a high-frequency electric furnace, or other arrangement. The grids of the valve are supplied from a second oscillatory circuit consisting of a capacity L and an inductance M coupled to the auto-transformer G, and its middle point is connected to the cathode E. When the circuit L–M is tuned to the frequency of the generator the grid cathode potentials are displaced by $\frac{\pi}{2}$ deg. behind the cathode potentials.

The electromotive forces at the terminals of the coil G and those which are induced at M are substantially in phase, the direction of the winding M being opposite to that of the coil G. Since there

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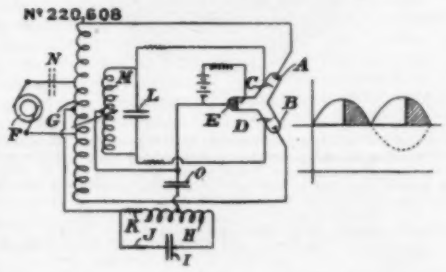
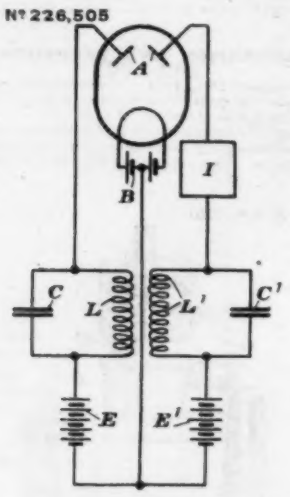


is resonance in the secondary, the current is in phase with the electromotive force. The electromotive forces at the terminals of the capacity, *i.e.*, at the grid terminals, will lag $\frac{\pi}{2}$ deg. behind the current and the grid potential lags by this amount behind the anode potential. Under these conditions the arc will start in the middle of the alternations. The electromotive force acting upon the oscillating circuit H and I will have the form shown in the right-hand illustration, this diagram representing an undulating and not an alternating electromotive force, and its frequency is double that of the generator. If the circuit H and I be tuned to the fundamental frequency of this electromotive force the impulses produced by the discharge tube will maintain an oscillating current of constant amplitude. If it be desired to vary the amplitude the times at which the arcs are started in the tube are modified by changing the phase of the potential on the grid. For this purpose the circuit may be put out of tune by any suitable means. If the generator supplies high-frequency current, a capacity is added at N in order to produce resonance in the circuit G. A condenser is also provided at O. There are two other illustrations showing the scheme applied to a two-phase and a three-phase supply.—*October 19th*, 1925.

226,505. November 7th, 1924.—IMPROVEMENTS IN THERMIONIC OSCILLATION GENERATORS, Telefunken Gesellschaft für Drahtlose Telegraphie m.b.H., of Hollescher Ufer 12/13, Berlin.

For the generation of oscillations in accordance with this invention use is made of a valve with two anodes and a cathode, each anode being connected through a separate oscillatory circuit and a source of current to the filament, the voltages on the two anodes being 180 deg. out of phase with one another. The two anodes are shown at A and the filament battery at B. The left-hand anode is connected through an oscillatory circuit C L, and a battery E to the middle point of the battery B. The other anode is connected through another oscillatory circuit

in a similar way. In this case, however, there is an impedance at I. On completing the circuit an oscillation is produced in one of the oscillatory circuits and it induces an alternating current in the circuit coupled to it. By suitably adjusting the valves of the inductance and capacity of the two oscillating

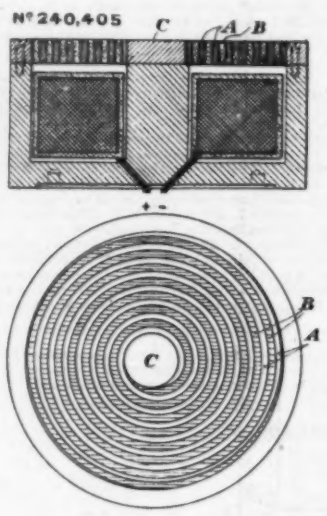


circuits and the impedance in the right-hand anode connection alternating potentials which are displaced 180 deg. in phase relation are applied to the anodes. The oscillations in one circuit will therefore be maintained by those in the other.—*October 22nd*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

240,405. February 17th, 1925.—IMPROVEMENTS IN AND RELATING TO MAGNETIC CHUCKS AND THE LIKE, Magnet-Werk G.m.b.H., Eisenach Spezialfabrik für Elektro-magnet-apparate, of Eisenach, Germany.

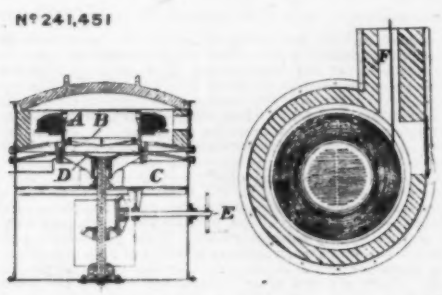
In the construction of magnetic chucks in accordance with this invention strips of magnetic and non-magnetic material are



wound in the form of a spiral and secured in position. The magnet and winding do not present any unusual features, but the pole part is made of a strip of brass A and a strip of iron B, which are wound together in the form of a spiral around the circular core piece C.—*October 22nd*, 1925.

241,451. March 20th, 1925.—FURNACES FOR WIRE, A. F. Jacquemin, Saucourt, par Doulaincourt, Haute Marne, France.

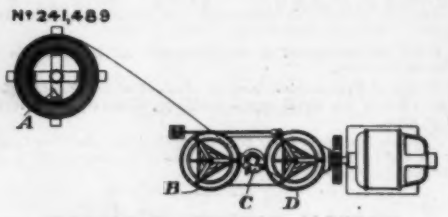
This furnace is intended for heating the wire supplied to bolt-making machines and for similar purposes for which a continuous feed is desirable. It comprises a drum A of refractory metal



for carrying the coil of wire. In the centre of this drum there is a grate B for fuel. Air is supplied to the fire through the chamber C and a little water is kept in the shallow basin D by means of the hollow spindle carrying the drum. The gear and hand wheel E are for turning the drum to ensure its even heating. The hot wire is drawn off through the opening F.—*October 22nd*, 1925.

241,489. June 4th, 1925.—WIRE-DRAWING BENCHES, F. H. Nullmeyer, Struthers, Mahoning County, Ohio.

This wire-drawing machine might be described as being of a semi-continuous type. The wire rod A is drawn off a swift round a loose block B and through a die C on to a block D driven by the motor shown. When the whole of the length has been drawn on to the block D the table carrying the two blocks is turned through 180 deg. so that the loose block is in engagement with the driving gear and the block D becomes free. The wire is



then threaded through a smaller die to be wound on to the block B and the process is repeated as often as is necessary.—*October 22nd*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Chamber of Commerce, New-street, Birmingham. Lecture, "The Powers and Duties of an Arbitrator," by Mr. G. Louis Dawson. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Official visit to the Shipping, Engineering and Machinery Exhibition at Olympia, London, W. Reception and luncheon. 1 p.m.

INSTITUTION OF WATER ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers: "Recent Studies Relating to the Purification of Water, and the Action of Various Waters on Lead and Copper Pipes," by Dr. John C. Thresh and Mr. John F. Beale; "Further Observations on the Biology of Jersey Waterworks," by Dr. W. Rushton and Mr. P. A. Aubin; "An Analysis of Scottish Rainfall Records," by Mr. W. N. McClean; "The Afforestation of Watersheds," by Lieut.-Colonel J. R. Davidson. Lecture, "The London Water Supply," by Mr. H. E. Stilgoe. 10.30 a.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Super-heterodyne Reception," by Mr. A. E. Bowyer-Lowe. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. "Transmission of Power—the Present and the Future," by Mr. G. Constantinesco. 7.30 p.m.

SATURDAY, DECEMBER 5TH.

INSTITUTE OF BRITISH FOUNDRYMEN: BIRMINGHAM, COVENTRY AND WEST MIDLANDS BRANCH.—Lecture Room of Pooley and Sons, John Bright-street, Birmingham. "The Melting and Pouring of Brass and Bronze," by Mr. T. J. Bamford. 6 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. Paper, "Some Metallurgical Points in Electric Steel Castings and Notes on Defects," by Mr. F. A. Melmoth. 4 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the stations and escalator tunnels of the City and South London Railway extension to Morden.

MONDAY, DECEMBER 7TH.

INSTITUTION OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—Chamber of Commerce, Birmingham. Annual meeting. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. General meeting of members. 5 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2.—Cantor Lecture, "Coal Ash and Clean Coal—III.," by Dr. R. Lessing. 8 p.m.

SOCIETY OF ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "The Growth of the Gothic Church Window," by Mr. H. E. Irving Taylor. 5.30 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, London, S.W. 1. Paper, "Modern Methods of Roadmaking," by Colonel C. H. Bressey. 8 p.m.

MONDAY TO FRIDAY, DECEMBER 7TH TO 11TH.

SMITHFIELD CLUB SHOW.—Royal Agricultural Hall, Islington, London, N. 1. 9 a.m. each day.

TUESDAY, DECEMBER 8TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Paper, "Oil Sand and Production," by Mr. West. 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower Hill, London, E. 1. "Powdered Fuel Developments," by Mr. M. L'Herminier. 6.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Broadgate Café, Coventry. Paper, "Sleeve-Valve Engine Development," by Mr. W. Ferrier Brown. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Electrical Engineering Lecture Room, Royal Technical College, Glasgow. Paper, "Electricity in Mines," by Major E. I. David. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Selection and Properties of Steels Used for Oil Well Boring Equipment," by Mr. J. H. S. Dickenson. 5.30 p.m.

WENDESDAY, DECEMBER 9TH.

BRITISH ACETYLENE AND WELDING ASSOCIATION.—Old Colony Club, Aldwych House, Aldwych, London, W.C. 2. Paper, "A Review of the Present Position of Oxy-acetylene Welding and Cutting," by Mr. C. S. Milne. 8 p.m.

INSTITUTION OF CHEMICAL ENGINEERS.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Magnetic Separation," by Colonel B. I. Rolling. 8 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper, "Oil Fuel for Commercial Purposes," by Mr. J. V. Stevens. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal meeting. Discussion, "The Use of Explosives for Scouring Purposes in Tidal Rivers," introduced by Mr. C. H. J. Clayton. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the works of the Westinghouse Morse Chain Company, Ltd., the Foster Instrument Company, and the Bowyer-Lowe Company, Ltd., at Letchworth, Herts. Train leaves King's Cross 10 a.m.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting. Talk on "The Acoustics of the Head-phone and Loud Speaker," by Mr. A. E. Bawtree. 6 p.m.

THURSDAY, DECEMBER 10TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85-88, The Minories, London, E. 1. Joint meeting with the Institution of British Foundrymen. Paper, "Commercial Aluminium Alloys from the Users' Point of View," by Mr. J. B. Hoblyn. 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Great Northern Hotel, Leeds. Paper, "Concrete Granary at Hull," by Mr. E. F. Sargeant. 6.30 p.m.

OPTICAL SOCIETY.—Imperial College of Science and Technology, South Kensington, London, S.W. 7. Papers, "General Principles," by Colonel H. S. L. Winterbotham; "Perspective," by Lieutenant-Colonel M. N. MacLeod; "Precision," by Lieut. M. Hotine. 7.30 p.m.

FRIDAY, DECEMBER 11TH.

INSTITUTION OF MECHANICAL ENGINEERS.—General Meeting, Storey's Gate, Westminster. "Cast Iron and Modern Engineering Practice," by J. G. Pearce, and "Some Applications of Research to Modern Foundry Practice," by J. E. Fletcher. 6 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department, The University, St. George's-square, Sheffield. Paper, "Nickel Silver," by Professor F. C. Thompson. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Metallurgical Department, University College, Singleton Park, Swansea. Paper, "Modern Metallurgy," by Professor J. H. Andrew. 7.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Induction of and address by the President, Mr. J. S. Highfield. 7.30 p.m.

RAILWAY CLUB.—65, Belgrave-road, London, S.W. 1. Paper, "Some Little Known Features of Railway Publicity," by Mr. J. R. Hind. 7.30 p.m.

SATURDAY, DECEMBER 12TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower Hill, London, E. 1. Juniors' Social. 7 p.m.

MONDAY, DECEMBER 14TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Aluminium and its Alloys as Used for Engineering Purposes," by Dr. H. Hyman. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Chamber of Commerce, New-street, Birmingham. Paper, "Sleeve-Valve Engine Development," by Mr. W. Ferrier Brown. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES SECTION.—Storey's-gate, Westminster, London, S.W. 1. Paper, "The Mechanical Transmission of Power on Electric Locomotives," by Mr. V. F. Cornish. 7 p.m.

TUESDAY, DECEMBER 15TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower Hill, London, E. 1. Paper, "Economic Application of the Scott-Still Engine," by Mr. J. A. Sim. 6 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Paper, "Pressure-Boosting Station for the Waterworks of Monte Video," by Mr. A. Honeysett. 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow. Paper, "The Economic Value of Bunker Coal," by Mr. Otto Kahrs. 7.30 p.m.

WEDNESDAY, DECEMBER 16TH.

CHEMICAL ENGINEERING GROUP.—Works visit. Dinner and meeting at Nottingham. 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' Meeting. Paper, "Press Tools," by Mr. F. G. E. Clarke. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. Graduates' Meeting. Paper, "Sales and Service," by Mr. C. A. Edwards. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Students' meeting. Vernon-Harcourt Lecture. "The Development of Harbour and Dock Engineering," by Sir Cyril R. S. Kirkpatrick. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Visit to the works of C. F. Casella and Co., Ltd., Walthamstow. 5 p.m.

THURSDAY, DECEMBER 17TH.

ROYAL AERONAUTICAL SOCIETY.—7, Albemarle-street, London, W. 1. Informal discussion on "Aero-engine Starting Gear." 6 p.m.

FRIDAY, DECEMBER 18TH.

JUNIOR INSTITUTION OF ENGINEERS.—15, Savoy-hill, Strand, London, W.C. 2. Lecture and demonstration of industrial and domestic electric lighting. 7 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE ENGINEERING AND COMMERCIAL COPYING COMPANY asks us to state that it has opened a photostatic studio and office at 137, Victoria-street, S.W. 1.

MM. SCHNEIDER ET CIE., of Paris, whose London office is 28 and 32, Victoria-street, London, S.W. 1, ask us to state that they have just acquired the licence to manufacture in France Burmeister and Wain engines of all types, single and double-acting, for marine and land purposes.

NEW ALLDAYS AND ONIONS, Ltd., ask us to announce that they are moving their London office from Stevenage House, 40-44, High Holborn, to 9, Victoria-street, Westminster, S.W. 1. Their new telephone number is Victoria 6137, and the telegraphic address "Typhoon Sowest London."

INTERNATIONAL OIL EXHIBITION.—The management of the Crystal Palace announces that a great International Oil Exhibition will be held from April 21st to May 8th, 1926. For this purpose the whole of the main exhibition building has been reserved, with over 100,000 square feet of exhibition space under one roof and all on the ground level. During the run of the Exhibition it is intended to hold an International Petroleum Congress and the chief Governments of the world are to be approached in connection therewith. The Exhibition is to be exclusively devoted to displays directly associated with the producing, refining, transport, and distribution of oil products.

A Seven-Day Journal

The Empire Exhibition Deficit.

JUDGING from the interim certificate of the auditors to the joint liquidators of the British Empire Exhibition, it would appear that the opening of the Exhibition for a second year has been justified on financial grounds, although scarcely as fully justified as the guarantors would have liked. After the close of the undertaking in 1924 it was announced that the deficit incurred was such that the guarantors would be called upon to furnish contributions at the rate of 20s. in the pound. The second season has reduced that call to 15s. in the pound, the total loss as at present determined having been £1,581,905. The guarantors, among whom are to be found some well-known firms connected with the engineering and allied industries, have received notices of call to which have been added the intimation that interest at the rate of 5 per cent. per annum will be added to any portion of the sum demanded remaining unpaid on December 31st. In round figures, the total capital expenditure on the Exhibition was 3 million pounds. About a quarter of a million, it is estimated, will be recovered by the realisation of the assets, after allowing for the cost of demolition. The revenue totalled something less than 3 millions, while ordinary expenditure amounted to over 1¼ millions, so that the balance available to set against the net capital expenditure is not much more than ¾ million. From the details of the capital expenditure, it is learned that the most costly constructional feature was the Stadium, the construction and equipment of which involved an expenditure of £507,183. The Palace of Engineering was second with £454,446, and the Palace of Industry third with £333,335. A contribution of £35,335, secured on debentures, was made towards the cost of constructing the "Never-Stop" Railway.

The All-Electric House.

AN excellent description of an all-electric house and some interesting facts concerning the cost of running it were given in a paper read a few days ago by Professor S. Parker Smith before the Institution of Electrical Engineers. Being in need of a house in Glasgow, a city in which the Corporation encourages the domestic use of electricity, the author decided to build a ten-roomed house, and to avoid entirely the use of gas and coal. Electricity is used for all purposes, including the heating of all water, which is one of the most troublesome problems associated with the electrification of private residences. By using a well-lagged tank in which immersion heaters are placed, and by heating the water at night when current can be obtained at reduced rates, Professor Smith has succeeded in obtaining a cheap and abundant supply of water for all purposes. The total cost of the units consumed for lighting, heating and cooking, washing and drying, water heating and ventilation—in fact, for all the usual domestic operations—amounts to £43 8s. per annum, or 16s. 8d. per week. The average cost per day per person is only 4¾d. A fixed charge of £12 10s. is paid and all current used during the day is supplied at the rate of 0·5d. per unit, whilst the night load current is charged for at the rate of 0·375d. per unit. Needless to say, these terms are very moderate, and if they could be obtained from all electricity supply authorities, the use of electricity for domestic purposes would undoubtedly soon become much more general than it is. It is possible, however, that the Glasgow Corporation is really supplying Professor Smith with current at a loss.

The Size of Coal Wagons.

GIVING evidence on Tuesday before the Coal Commission, Mr. W. T. Stephenson, Lecturer on Transport at the University of London, dealt with the effect exercised on the economics of the coal industry by the size of the wagons used for the carriage of the mineral. A feature of our railways, he said, was the small size of the wagon normally used for the transport of coal. There were still a few 4-ton wagons in employment, although the number was rapidly diminishing. To-day the average capacity of our coal wagons was probably about 9 tons. The railway companies long ago realised the economy to be derived from the use of larger wagons. The North-Eastern Railway concentrated on the 20-ton wagon—about the largest that could be carried on four wheels—and to-day about 55 per cent. of its coal traffic was handled in such wagons. The Great Western Railway was at present making strong efforts to extend the adoption of 20-ton wagons in South Wales. Nevertheless, little progress was being made, and many 12-ton wagons—the smallest size now allowed by the railways—were being built by colliery owners. The private ownership of wagons was a survival of a practice inherited by the railways from the turnpike roads, and its abolition provided a big possibility of effecting an immediate saving. There were about 600,000 privately owned wagons in the kingdom, of which some 450,000 were used for the transport of coal. Mr. Evan Williams, President of the Mining Association, suggested that the coal arrived at its destination in a better condition in a small wagon than it did in a large, and Mr. Stephenson agreed that in a large wagon there was a little more small coal. To Mr. Williams' contention that the re-equipment of our railways with 20-ton coal wagons would involve an expenditure of 80 million pounds, Mr. Stephenson replied that he did not suggest scrapping the existing stock, but its replacement, as it became worn out, with 20-ton vehicles. The 20-ton wagon, as compared with one of 10 tons capacity, could carry 100 per cent. more coal. Its tare weight was only 33 to 50 per cent. greater, and its length 16 to 30 per cent. more. The capital cost was only increased by 50 per cent. per wagon. Less time was required for coupling and uncoupling, and a given engine could haul a train containing 25 per cent. more weight of coal.

Coal Cutting Machines in Russia.

INFORMATION regarding the industrial expansion of Russia is generally of an official character which does not permit of independent verification. Nevertheless, it is particularly interesting to learn that the Soviet Government is organising industry on modern lines, and that by the introduction of coal-cutting and other machinery it has been enabled to increase production at the collieries, pay higher wages to the miners and reduce the cost of coal to consumers. Coal-cutting machines were first employed in the collieries at Briansk and Lidiev. In 1923 there were thirty-five machines in operation. In the following year the number was more than doubled, and there are now about 100 coal-cutting machines in thirty-two collieries. It is proposed to install in forty collieries 150 big machines and 85 of a smaller type, which will produce annually about 550,000 tons of bituminous coal and 700,000 tons of anthracite, representing 9 per cent. of the total output. In the same connection it may be noted that modern machinery and plant are being employed for the treatment of peat, which exists in practically unlimited quantities in Russia. It is curious that while miners in this country frequently regard the coal-cutting machine as a device which aims at depriving them of a living, the Soviet Government has discovered that this labour-saving mechanism is necessary to the prosperity and well-being of the same working class in Russia.

An Electricity Scheme for the Midlands.

FOR the supply of electricity in the West Midland district a scheme involving an outlay of £1,112,599 has just been sanctioned by the Electricity Commissioners. It is claimed that under the scheme cheaper power will be obtainable than by the present method of extending small plants working separately and independently. A conference met to discuss the proposals as far back as 1918, but since that time the area originally outlined has been modified and re-arranged, and the conference has latterly concerned itself with the organisation and supply of electricity for South Staffordshire, stretching westwards beyond the Severn, and including a portion of Shropshire. Transmission lines between West Bromwich and Walsall, Walsall and Wolverhampton, and West Bromwich and Ocker Hill, are apparently to be erected forthwith. Plant with a capacity of 10,000 kilowatts is to be added to the Walsall station, and the erection of a 100,000-kilowatt plant at Ironbridge is included in the scheme. The cost of linking up the present stations will be about £200,000, whilst the extensions at the Walsall station will cost £175,000. The proposed figures at which the various undertekings will be transferred to the Joint Authority are—Wolverhampton Corporation, £379,550; Walsall Corporation, £164,095; West Bromwich Corporation, £92,901; Shrewsbury Corporation, £28,824; and the Midland Electric Corporation for Power Distribution, Ltd., £447,229.

The Future of American Shipping.

SOME far-reaching recommendations, which if applied may have an important bearing on the future development of the United States mercantile marine, are outlined in a report which has recently been prepared by Mr. G. H. Dalton, of Cleveland, for President Coolidge. The report is strongly in favour of private enterprise as opposed to governmental operation, and it recommends that the existing services should be transferred to private ownership as soon as possible, a guarantee of continued operation being called for. Consolidation of some of the existing services is suggested, and it is proposed that the co-operation of the Department of Commerce should be sought with a view to opening up new lines. It is further advised that the Shipping Board should be completely separated from the Emergency Fleet Corporation, and that all ships and terminal facilities should be transferred to the latter body, the constitution of which should be revised and to which representatives of the Atlantic, Pacific and Gulf regions should be added. The general policy of converting existing steam vessels into motor ships is approved. An interesting section of the report deals with the scrapping of ships. Mr. Dalton seems to think that the present time is opportune for the scrapping of more ships, as prices for scrap material are good. It is suggested that the shipyards which are now idle and are awaiting a return of shipbuilding activity might be employed on this work during the present period of slackness. A proposal is made to dispose of surplus ships in small numbers from time to time, so that they could be spread over the various undertakings for scrapping, a procedure which, it is suggested, might benefit several industries.

Scott-Still Engines for a New Motor Ship.

ON this page in our issue of November 20th we referred to the continued successful operation of the Scott-Still-engined motor ship Dolius, belonging to the Blue Funnel Line—Alfred Holt and Co., of Liverpool. The Dolius is fitted with twin-screw motors, designed to develop a total of 2500 brake-horse-power at a normal speed of 120 revolutions per minute, and her average fuel consumption works out at approximately 8·5 tons per day for all purposes, at a speed of 11 knots. She is a 400ft. ship with a gross tonnage of 5994 and a deadweight carrying capacity of about 8000 tons. Considerable interest, therefore, is attached to the announcement that Alfred Holt and Co. have instructed Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, to proceed with the construction of the larger and more powerful motor ship which, it will be recalled, was ordered some time ago, but upon which work had been suspended. We are informed that the new ship will have a length of about 450ft. and a breadth of 58ft. Her engines, which will be of the Scott-Still double-acting two-cycle type, are to be designed to develop 5000 shaft horse-power on twin shafts, an output just double that of the engines of the Dolius.

The Closed Dockyards.

THE closing of the Royal dockyards at Pembroke and Rosyth was the subject of a discussion between the First Lord of the Admiralty and a deputation of Welsh and Scottish Members of Parliament, which waited upon him on Tuesday. The Welsh Members dealt chiefly with the provision of alternative employment for the men discharged from Pembroke, and advanced the suggestion that part of the work of breaking up the war vessels now on the scrapping list should be placed in that town. Mr. Bridgeman promised to consider this proposal sympathetically. Replying to the views expressed by the Scottish Members, he expressed his agreement with their opinion that Rosyth was the most up-to-date dockyard in the world for dealing with capital ships. Such ships, however, were, he said, few in number to-day, and to equip the dockyard to deal entirely with smaller vessels would involve a heavy expenditure. About a thousand men from Rosyth and a slightly smaller number from Pembroke would, Mr. Bridgeman stated, be transferred to other dockyards in the South. The Scottish Members suggested that when the placing of orders for new naval construction was under consideration, favourable regard should be given to the claims of the Clyde yards, which would, they held, probably absorb a number of the Rosyth workmen who otherwise would be unemployed.

The Mersey Tunnel.

ON Tuesday the Joint Mersey Tunnel Committee took an important step towards the realisation of the scheme recently sanctioned by Parliament, after much debate, for the construction of a tunnel under the river Mersey to connect Liverpool and Birkenhead. On that day they decided to let the contract for sinking the working shafts at the two ends and for boring the two preliminary headings under the river to Edmund Nuttall, Sons and Co., Ltd., of Trafford Park, Manchester. Each of the headings will measure 15ft. by 12ft., and from them the two sections of the traffic tunnel will subsequently be formed under a fresh contract, to be placed at a later date. The contract price for the preliminary work is £443,079 14s., and it has been agreed that the work shall be completed within twenty-five months. The inaugural ceremony in connection with the construction of the tunnel is to be performed by Princess Mary on the 16th inst. The whole scheme, it is estimated, will cost something in the neighbourhood of £5,000,000, and it is anticipated that the tunnel will be completed and opened for traffic by the end of 1928 or the beginning of 1929.

A Power Station Breakdown.

ON the morning of Tuesday, the 8th, the Vereeniging Generating Station of the Victoria Falls and Transvaal Power Company was put out of action by the breaking of the shaft of one of the generating sets. The machine was wrecked, and other sets in the station were damaged, resulting in the complete plant being put out of commission. One theory, and a very probable one, is that the emergency governor failed to act. The other three stations of the company are said to be endeavouring to keep the Rand mines going, but it will probably be some little time before the Vereeniging Power Station can again take its share of the load. It is, of course, well known that, notwithstanding its title, the Victoria Falls and Transvaal Power Company generates its current in steam stations. According to Garcke's "Manual of Electrical Undertakings for 1924–1925," the Vereeniging Station is equipped with A.E.G. Curtis turbo-generating sets.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. L.*

PERIOD 1914 TO 1924 (*concluded*).

DETAILS.

Boilers.—There has been a tendency during the last few years to slope the fire-box roof downwards towards the back, and also to slope the back plate outwards from top to foundation ring. This has been done on several railways, both for large Belpaire and round-topped fire-boxes, and has been copied from American practice.

Ramsbottom safety valves, though still used, are rapidly giving place to pop valves of the Ross pattern. The "pop" valve, which has been used for a long time in America, is derived from the old T. Adams's valve, which had an extended circular outer lip, and was patented in this country in 1873 and 1875, the latter patent covering an annular pop chamber. The R. L. Ross valve was patented in 1902 and 1904, but its extended use for locomotives really belongs to the present period.

Experiments were made on the G.C.R. during 1918–9 in burning pulverised fuel. Mr. J. G. Robinson's apparatus for this purpose was fully described and illustrated in THE ENGINEER April 25th, 1919.

Bogies and Pony Trucks.—Mr. R. E. L. Maunsell's S.E. and C.R. 2–6–0 engines of 1917 were provided with pony trucks, in which the pivot is hemispherical and rests in a hemispherical socket. The lateral displacement is controlled by inclined planes which work in an oil bath. The combination of spherical pivot and central inclined planes is similar in principle to that used for a number of years for bogies on the P.L.M. Railway, France, but the latter do not work in an oil bath. The trailing four-wheeled bogie of the S.E. and C.R. 2–6–4 tank engines is similar. For drawings see THE ENGINEER, October 5th, 1917.

Booster.—In 1923 Mr. Gresley fitted one of the Ivatt "Atlantic" engines on the L. and N.E.R. with one of the American Franklin Supply Company's "boosters," consisting of a small auxiliary engine arranged underneath the footplate to drive the trailing axle through the intermediary of spur gearing. The "booster" is used for starting and when ascending heavy gradients at slow speeds When the speed exceeds a predetermined amount the booster is automatically cut out. See THE ENGINEER, February 8th, 1924.

Motion, Valves and Valve Gear.—In order to reduce the weight of the engine and especially of the reciprocating masses, Mr. Gresley has adopted nickel-chrome steel. The piston-rods are hollow. Particulars of the steel used and detailed drawings of the motion parts of the L. and N.E.R. "Pacific" engines were published in THE ENGINEER of January 26th and April 27th, 1923.

Piston valves with long laps and travel, introduced previously by Mr. Churchward on the G.W.R., have also been adopted on other railways. The L.M.S. 4–6–0 tender and 4–6–4 tank engines, by Mr. G. Hughes, have 6¼in. maximum travel and $1^{3}/_{16}$in. steam lap. Although the reintroduction of long laps and travel appears to have been due to the influence of later American practice, it may be added that slide valves and gear of the L. and S.W.R. engines, by Joseph Beattie and his successor, W. G. Beattie, during the 1868–1876 period were similarly arranged.

In 1915 the L. and N.W.R. converted a two-cylinder 4–6–0 engine to one with four cylinders. Each pair of cylinders on the same side of the engine have two piston valves on the same stem on C. F. Dendy Marshall's system. The piston valve heads are arranged to avoid the necessity for crossed ports. There are two pistons on the spindle, each with two heads, of which the front head of the front piston serves the front port of the outside cylinder, and the back head of the same piston serves the back port of the outside and the front port of the inside cylinder. The front head of the back piston serves the back port of the inside cylinder, which is placed slightly further back than the outside cylinder. To balance the valve the back piston has a dummy head at the back. Dendy Marshall's system was illustrated in THE ENGINEER, September 24th, 1915.

The 0–8–4 tank engines, No. 16 in Table B., page 600, have Joy's valve gear, standard with the L. and N.W.R 0–8–0 mineral engines previously built at Crewe. They are probably the last engines which will be provided with this gear, owing to the weakness caused by the hole in the connecting-rod in the case of modern engines working heavily with high boiler pressures. Some of the L.M.S.—L. and N.W. section—4–6–0 express engines, with inside cylinders have been altered by the removal of Joy's gear and the substitution of a modification of Walschaerts gear designed by Capt. H. P. Beames in 1923. The gear is outside, the oscillation of the expansion link being produced by the usual return crank and excentric rod, but the movement of the combination lever is obtained from a connecting-rod attached to an extension of the coupling rod in front of the driving crank pin. The combined movement is imparted to an outside dummy spindle, which is connected to the real inside valve spindle by a rocking lever. The 4–6–0 engine, by W. Beardmore and Co., for the L.M.S.R., shown at Wembley Exhibition in 1924, has this gear. See drawings in THE ENGINEER, of June 27th, 1924.

Mr. Gresley's lever gear for three-cylinder engines, and also that of Mr. Holcroft have already been mentioned. A special feature of the former is that the fulcrum of the long lever is now provided with roller bearings. For details of the gear see THE ENGINEER of July 26th, 1918, and January 26th, 1923.

A new combined hand and steam reversing gear by Armstrong, Whitworth and Co., Ltd., 1923, fitted by them to locomotives for India, was described un THE ENGINEER of August 17th, 1923.

Lubrication.—Mechanical or forced feed lubrication is now frequently supplied to the main bearings of large engines. On some railways, of which the locomotives, even when superheated, have the cylinders and valves lubricated by means of sight feed displacement lubricators, mechanical lubrication is used for the bearings.

LOCOMOTIVE TENDERS.

Very little has been said in the foregoing history on the subject of tenders, and therefore a few brief notes may be of interest.

Omitting the primitive tenders of the Stockton and Darlington and Liverpool and Manchester engines, several of which have been shown in the illustrations, the first type is that of R. Stephenson and Co. and Bury. Stephenson's four-wheeled tender of 1836–7, as shown in Tredgold's "Steam Engine," had wood frames with iron axle guards and axle-boxes outside the wheels. The springs, on which the wood frame rested directly, were situated immediately above the axle-boxes. This frame was developed from that of the tender of the Rocket. In an improved form it was adopted on the Grand Junction Railway in the early Crewe engines, and remained standard on the L. and N.W.R., though with six wheels, until the end of F. W. Webb's superintendency in 1903 by which time it was long out of date. But it was very cheap to construct, and its long continuance on the L. and N.W.R. was partly due to the small water capacity —1800 gallons—which the use of water troughs permitted. The L. and N.W.R. standard tender weighed only 12 tons 1 cwt. empty. Similar tenders were used on many of E. Fletcher's N.E.R. engines until 1875.†

Bury's four-wheeled tenders of 1837 to 1845 were of a similar type, and were probably copied from Stephenson's design.

The date of the first six-wheeled tender is uncertain, but Sir D. Gooch's G.W.R. tenders of 1840–1842 ran on six wheels. The framing was of the outside sandwich pattern, and double elliptical laminated springs were placed between the flitch plates of the frames immediately above the axle-boxes. This tender is shown in Fig. 38 *ante*. In 1846 Gooch discarded this pattern for one somewhat similar in design and appearance to the above wood-framed tenders, but with the important difference that the frames were of iron. About 1855 he returned to the sandwich-framed tender, as in Fig. 110 *ante*, with springs placed above the platforms.

The Vulcan Foundry tender of 1846 had inside frames and bearings, as in Fig. 48 *ante*. This design was rare in British practice until Stroudley adopted it on the Brighton Railway in 1880, with the object of making the axles interchangeable with the carrying axles of the engines. It was discarded by his successor in 1893.

We now come to what may be termed the first standard British tender, which had outside frames and axle-boxes and the springs placed outside *above* the platforms. The origin of the design is uncertain, but Sharp Brothers built this type in 1842, with sandwich frames and four wheels, and in 1846 with six wheels. It appears in Stephenson's York, Newcastle and Berwick express engine of 1848. The date of the first use of solid plate frames for this type of tender is unknown; but the earliest known to the writer were made by E. B. Wilson and Kitson about 1850. This type of tender was developed by Cudworth on the S.E.R., and his 1857 design—illustrated in Colburn, Plate 28—was used on nearly all railways, except the L. and N.W.R., and was built with modifications until 1897 by J. Stirling. For the Northern Counties Committee, Ireland, and by Beyer, Peacock for the Dutch State Railways, similar tenders have been built during the early years of the present century. The sandwich-framed tender was gradually abandoned between 1863 and 1870, the last to construct it being E. Fletcher on the N.E.R.

Hawthorn's old tender of 1848 was not so convenient, since the springs were placed behind the sandwich framing, immediately above the axle-boxes. Nevertheless, this type, with plate frames, was adopted by P. Stirling on the G.N.R. from 1867 until 1882 and by S. W. Johnson on the G.E.R. and M.R. from 1867 to 1878. Subsequently, Johnson altered all these Midland tenders to the second standard type, to be mentioned below, to render the springs more accessible.

Stroudley's tenders of 1871 to 1878 had the springs underhung beneath the outside axle-boxes. D. Drummond, who in his early days copied Stroudley with great fidelity, adopted this design on the North British and Caledonian Railways. Stroudley abandoned it in 1880.

The second and present-day standard British tender with outside plate frames has the springs immediately above the axle-boxes *below* the platforms. Not only are the springs visible and accessible, but the tanks can be widened to the edge of the platforms. J. E. McConnell on the L. and N.W.R. (Southern Division) was apparently the first to introduce this type in 1851, and Joseph Beattie followed almost immediately afterwards on the L. and S.W.R., though the earlier tenders of the latter had double elliptical plate springs. Similar tenders with ordinary plate springs were made by the Vulcan Foundry in 1853. For many years the only British railways which constructed such tenders were the L. and N.W.R. at Wolverton until 1863, and the L. and S.W.R., which has always used them since 1851. In 1876 W. Adams introduced this design on the G.E.R., and it was perfected in its present form by S. W. Johnson on the Midland Railway in 1879. From that time onwards it rapidly spread to every railway in the country, except the L. and N.W.R., which had discarded McConnell's design in 1863, and continued with the old Crewe wood-framed tender until 1903.

For many years the tender tanks were of the horse-shoe pattern, surrounding the flat floor which formed the coal space. The fireman had to spend much time in shovelling coal forward to a convenient working position. During the 'seventies the floor was raised to gain additional space underneath for water. P. Stirling, S. W. Johnson, W. Stroudley, and W. Adams were amongst those who did most towards the improvement in tender design at this period, when the inclined floor to cause the coal to work forward was introduced on several railways.

Until about 1868 the water capacity of a six-wheeled tender rarely exceeded 1600 to 1800 gallons. From 1870 to 1875 2000 to 2200 gallons was the average capacity, though the first tenders of P. Stirling's G.N.R. 8ft. singles of 1870 carried 2700 gallons. S. W. Johnson's Midland tenders of 1879 had a capacity of 2950 gallons, increased to 3250 gallons in 1885, and until the end of the century the usual capacity of six-wheeled main line tenders rarely exceeded 3500 gallons. At the present day there are a considerable number with a capacity of 4000 gallons of water and over 5 tons of coal.

Water pick-up apparatus, introduced by J. Ramsbottom in 1860, was used only on the L. and N.W.R. until about 1887, when the Lancashire and Yorkshire Railway put down water troughs. In the latter case one of the main considerations was the limited size of the then existing turntables, which necessitated a tender of short wheel base for 4–4–0 passenger engines. The first L. and Y.R. 4–4–0 engines of 1880 had to be built with four-wheeled tenders on this account, though subsequent engines from 1881 onwards had comparatively small six-wheeled tenders. But it was not until the early years of the present century that the Ramsbottom troughs and water pick-up apparatus were generally adopted by other railways.

Eight-wheeled Tenders.—The first were J. Manson's tenders of 1890 on the Great North of Scotland Railway. They had an inside-framed leading bogie, but the two hind axles were rigid with outside bearings in the main frame. The first double-bogie tenders were built at St. Rollox for J. F. McIntosh's Caledonian engines of 1897. The bogie axle-boxes were outside, with single inverted springs, the load being carried on the boxes by compensating beams. Similar tenders were built by S. W. Johnson in 1900 for the ten large 4–2–2 engines, one of which was exhibited at Paris in that year. In 1902 Johnson altered the spring gear and adopted an independent laminated spring for each axle-box. These large tenders, which had a capacity of 4500 gallons, were nicknamed "water carts" on the Midland. When water troughs were put down subsequently the double-bogie tender was abandoned, and those in use were converted to the standard 3500-gallon six-wheeled type by cutting down the tanks.

D. Drummond on the L. and S.W.R. in 1901 designed his double-bogie tenders with inside bearings throughout, an awkward arrangement which renders the springs inaccessible. This remained the standard tender until Mr. Urie in 1917 adopted the double-bogie type with outside bearings and independent springs, similar to Mr. Johnson's 1902 type on the Midland. It may be added that on the L. and S.W.R. there is no level stretch of line conveniently situated where water troughs could be put down.

The double-bogie tender has a tendency to roll somewhat, and possibly for that reason eight-wheeled tenders with four rigid axles have latterly been built. The Lancashire and Yorkshire was the first to adopt this type, about 1902, for 0–8–0 mineral engines, and in 1922 Mr. Gresley provided similar tenders for the 4–6–2 express engines of the G.N.R. The latter tender carries 7000 gallons of water and 9 tons of coal.

Sir Vincent Raven's six-wheeled "self-trimming" tenders for the N.E.R. were fully described in THE ENGINEER of September 17th, 1915. They have a

* No. XLIX. appeared December 4th.

† Since the above was written Sir John A. F. Aspinall, in his recent Hawksley lecture (Inst. Mech. Engineers, November 6th, 1925), stated that John Ramsbottom's reason for making the L. and N.W.R. tender frames of timber was that the tender between engine and train should be the weakest part of the train and that it should break up first in case of collision and thus save the passenger carriages.

capacity of 4125 gallons of water and 5½ tons of coal.

CONCLUSION.

In concluding this historical account of the British locomotive the writer desires to acknowledge the generous help which he has received from the Chief Mechanical Engineers of the leading railways, and from the leading locomotive building firms, who have kindly provided photographs, drawings, and other valuable information. He is also indebted to Sir John Aspinall for several details of interest, to Sir Robert Hadfield, Bart., F.R.S., for information with regard to steel castings, and to Hy. Bessemer and Co., Ltd., and Vickers Ltd., for particulars of steel tires made in the early days. Special thanks are due to R. Stephenson and Co., Ltd., of Darlington, for permission to reproduce a few of the illustrations from "A Century of Locomotive Building," by J. G. H. Warren. He is also greatly indebted to Mr. Warren for information regarding the early period of Messrs. Stephenson's activities and for other help, and to Mr. E. A. Forward, of the Science Museum, South Kensington, for details of the Sanspareil. Thanks are also due to the respective Institutions of Civil and Mechanical Engineers for particulars derived from their published "Proceedings," and to your contemporary *Engineering*, from the old issues of which a number of details have been derived. For the use of a number of photographs acknowledgment is made to the Locomotive Publishing Company, Ltd., of London, and to Mr. G. F. Bird for line drawings of Great Northern and old Great Western broad-gauge engines.

THE END.

The Shipping, Engineering and Machinery Exhibition.

No. IV.*

WE continue below our account of the exhibits at the Shipping, Engineering and Machinery Exhibition at Olympia.

STOTHERT AND PITT, LTD.

On the stand of Stothert and Pitt, Ltd., of Bath, an exhibit of great interest was the Burn patented reversing and reducing gear. This device, the invention of Mr. Lewis Burn, was exhibited as applied to marine propulsion and as applied to the driving of a planing or similar machine tool. It was also shown acting in the reverse sense as a speed-increasing gear, the application demonstrated consisting of a lighting dynamo driven from a motor car or ship's engine. The features claimed for the Burn gear are the silence of its operation, its positive action, the absence of gear wheels, the manœuvring ability which it confers in the case of a marine installation, and the instantaneous reversal of motion and quick return which it gives by purely mechanical means in the case of a machine tool drive.

One element of the Burn gear is shown in Fig. 57.

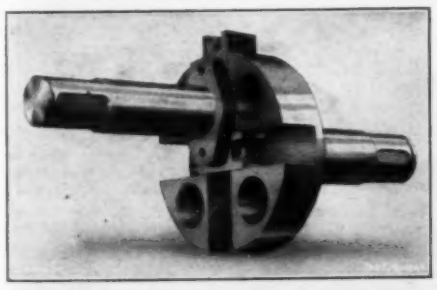


FIG. 57—BURN TRANSMISSION GEAR—STOTHERT & PITT

The driving shaft, on the left, is equipped with an arm at its end carrying two crank pins of equal radius. Each pin engages with a slipper sliding in a slot on the face of a disc attached to the driven shaft, on the right. The two slots are at right angles to each other, and the crank pin radius is equal to the distance by which the centre line of the driven shaft is displaced from the centre line of the driving shaft. If the two shafts be imagined mounted in fixed bearings, it will be perceived that the system gives a 2 to 1 speed reduction between the driving and the driven shafts. When one slipper is in the vertical position and exerting the maximum driving force on the disc, the other is horizontal and momentarily out of action. The device resembles an Oldham coupling, except that it can be shown that if the motion of the driving shaft is perfectly uniform, so, too, is that of the driven shaft.

The driven shaft, or, as we shall now call it, the displaced shaft, is—as shown in Fig. 58—itself equipped with a twin crank pin member, which engages through slippers with slots in a second disc at the end of a third shaft. The first and third shafts, the driving and the driven, are collinear, the radii of the two twin crank pin members being the same.

* No. III. appeared December 4th.

It will be gathered that were all the three shafts mounted in fixed bearings, this arrangement would give an overall speed reduction of 4 to 1.

The general arrangement of the gear, as applied between the engine and the propeller of a launch or other boat, is shown in Fig. 59. The first and third shafts are mounted collinearly in fixed bearings. At A and B are shown the slotted discs at the forward ends respectively of the displaced and the driven shafts. The whole action, or very nearly the whole of it, hangs upon the manner in which the displaced shaft is supported. At C is represented a brake drum arranged coaxially with the driving and driven shafts. This drum has a wide open boss, and is supported in

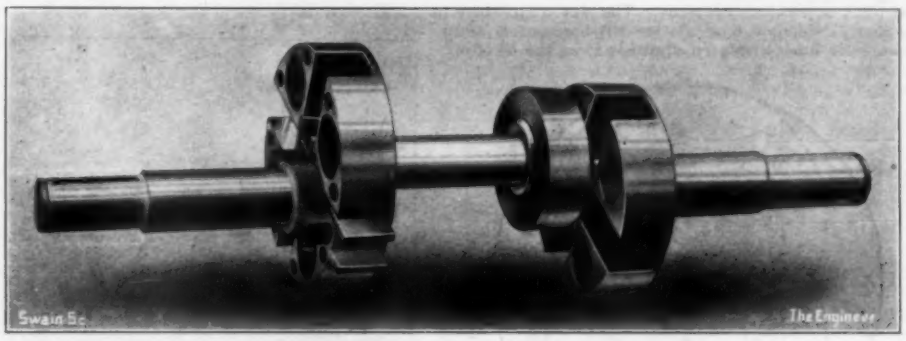


FIG. 58—BURN TRANSMISSION GEAR—STOTHERT AND PITT

fixed external bearings D D, applied round the boss. The brake drum C is thus capable of rotating coaxially with the driving and driven shafts. Within the bore of the brake drum boss a bearing is formed for the displaced shaft. Other matters being neglected, rotation of the brake drum within the bearings D would carry the displaced shaft round in a circular orbit about the centre line of the driving and driven shafts, the radius of the orbit being equal to the displacement of the shaft. A band is provided round the brake drum C and when it is tightened the drum is held steady. The bearings of all three shafts in this condition are fixed, and, as we have said before, the driven shaft will rotate at a quarter of the speed of the driving shaft. It is immaterial in what precise angular position the brake drum C is locked. If it is locked, not only will the speed reduction be 4 to 1, but the propeller will rotate in the same direction as the engine, and the boat will be given motion in the ahead direction.

A second brake drum is provided at E. This drum is mounted coaxially with the driving shaft on an internal bearing surrounding the after bearing of the driving shaft. This drum is also provided with a brake band, and can be locked or released, the two bands being under the control of the hand wheel indicated. Four bearings parallel with the driving shaft are formed in the drum E. Each such bearing contains a crank shaft, the pin of which enters a hole in the slotted disc A. One such crank shaft is to be seen at F. These four cranks have the same radius as the twin cranks at the ends of the driving and the displaced shafts.

It is somewhat difficult to picture or describe what occurs when the second drum C is released so as to be free to rotate while the first drum E is locked. The locking of the first drum does not prohibit motion of the first disc A. If a disc A—Fig. 60—is attached to a fixed disc E by means of four crank arms F, the centre G of the suspended disc may clearly be rotated about the centre H of the fixed disc in a circle of radius equal to the radius of the crank arms. Rotation is equally possible in either direction. In the Burn gear G is not only the centre of the displaced shaft and the first slotted disc; it is also the centre of one of the crank pins on the driving shaft, the twin of which is at J. These two pins G and J turn about H the centre of the driving shaft, in, let us say, the anti-clockwise direction. In the position drawn, the pin J is transmitting driving force to the disc A in the direction from right to left. The pin G is in the non-effective position, its slot being horizontal. A horizontal force applied to the disc A at J from right to left will result in movement being imparted in the same direction to the pins K L, that is to say, will tend to make these pins rotate *clockwise* about their respective crank shafts. The pins M N follow

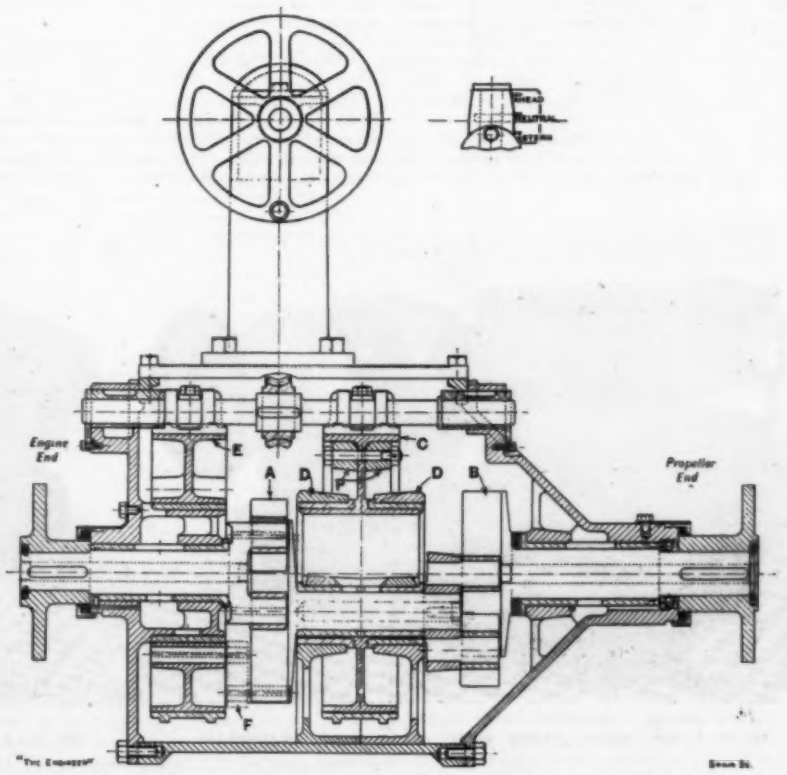


FIG. 59—BURN TRANSMISSION GEAR ARRANGED FOR PROPELLER DRIVING—STOTHERT AND PITT

suit, with the result that the centre G of the disc A rotates clockwise about the centre H of the driving shaft. This motion of G is accommodated by the orbital freedom of the displaced shaft given by the release of the brake drum within which that shaft is housed.

It may be objected that clockwise circular movement of the pins K L does not necessarily enforce clockwise circular motion on the pins M N. It is true that, kinematically, movement of the pins K L clockwise may be accompanied by anti-clockwise movement of the pins M N. In such an event the centre G of the disc A would follow, not a circular course, but a complex figure-of-eight path. Such a path as an alternative to a circle is rendered impossible

by the restraint of the floating bearing of the displaced shaft.

Two factors of importance must be noted. In the first place, it is fairly obvious from Fig. 60 that the centre G of the disc A makes one revolution about the centre H of the driving shaft in precisely the same time as the driving shaft takes to make one revolution, or, in other words, that the locking of the drum E cuts out the 2 to 1 reduction ratio otherwise given by the slipper and slot arrangement. In proof of this statement, the disc A may be supposed rotated through 180 deg. from the full-line to the dotted-line position. The net result of this rotation is equivalent to a simple hoist upwards of the disc A through a vertical distance equal to G J. The slot with which the crank pin J engages is still vertical, and the same end of it is pointing upwards. The slot with which the pin G engages is similarly still horizontal, and has merely been displaced upwards from the level of

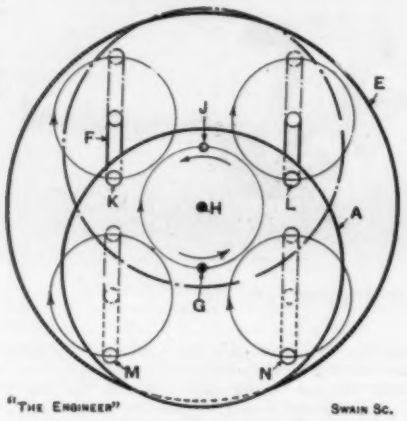


FIG. 60—DIAGRAM OF BURN TRANSMISSION GEAR

G to the level of J. If during this movement of the disc A the driving shaft also moves through 180 deg. the pin J will be at the level of G and the pin G will be at the level of J—that is to say, the pin J will during the 180 deg. movement show a net displacement from the top to the bottom of its slot, while the pin G will remain at the centre of its slot. Let it be supposed that the driving shaft rotates through 360 deg., while the disc A moves through 180 deg. In this case the pins J and G would be in precisely the same positions as they occupied before the movement began. The pin J would be half-way down the vertical slot, but the pin G would be in an impossible position, namely, at a distance J G below the level of the horizontal slot, with which it ought to be in engagement.

The second factor of importance to which we would refer is that, with the drum E locked, the links F do not transmit any driving force, all the work, as in the other setting, being done by the slippers and crank pins J G. This statement must be taken on trust.

Since the 2-to-1 reduction ratio is eliminated at the first disc A—Fig. 59—when the drum E is locked, this setting leaves only the 2-to-1 ratio at the disc B effective. The reverse motion of the propeller is therefore effected at twice the speed of the direct motion. When the drum C is unlocked the rotation of the displaced shaft in an orbit gives rise to an unbalanced force. This force is dynamically counteracted by a weight P bolted to the drum radially opposite the floating bearing.

A question may be asked as to what happens to the drum E and the crank arms F when this drum is freed and the drum C locked. In this, the ahead, setting the drum E is simply dragged round after the disc A by the crank arms. These arms do not rotate as in the other setting, but remain always parallel with themselves.

In Fig. 61 we illustrate the planing machine application of the Burn drive, which was exhibited at Olympia. This equipment is designed for a planer measuring 5ft. by 5ft. by 16ft. It includes a 15 horse-power variable speed direct-current or alternating-current non-reversing motor, and control equipment therefor. The gear gives a cutting speed of from 30ft. to 60ft. per minute, and a return speed of 60ft. to 150ft. The reducing and reversing gear is equipped with three brake drums instead of two. The fast return is obtained by locking the first drum and the cutting speed by locking the second. With the third drum locked, the transmission is neutral. Means are provided whereby it is possible to obtain a higher

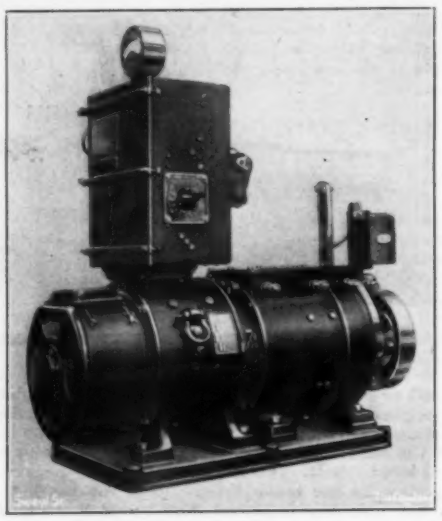


FIG. 61—BURN GEAR FOR PLANING MACHINE DRIVE

ratio of return to cutting speed than 2 to 1. It may be added that in the marine installation neutral transmission can be obtained by setting both brake drums free to rotate, and that by permitting the brakes to slip to a greater or less extent, the propeller can be caused to rotate at any desired speed up to the maximum.

THE SUNDERLAND FORGE AND ENGINEERING COMPANY, LTD.

The Sunderland Forge and Engineering Company, Ltd., of Sunderland and Belfast, exhibited a well-arranged group of electrical machinery designed for use aboard ship. The machines displayed included ship's lighting sets, electric winches, motors and various electric fittings for the deck, the engine-room and for cabin and navigating bridge use. There were two steam electric generator sets, one driven by an open type and the other by the enclosed type of engine fitted with forced lubrication. Both engines had a bore of 7in. with a 5in. stroke, the open type engine being designed for a speed of 315 revolutions and that of the closed type for 500 revolutions per minute. The two engines were directly coupled to a 10 K.W. and a 14·5 K.W. direct-current 110-volt generator respectively.

Among the motors built by the firm we noted three general purpose ship's motors. They included a 33 brake horse-power direct-current 220-volt drip-proof, compound-wound motor, designed for a speed of 750 revolutions per minute, and a three-phase 440-volt forty cycle induction motor of 3 horse-power, designed for the same running speed.

A 40 brake horse-power 220-volt direct-current motor, totally enclosed water-tight motor, designed for a speed of 600 revolutions per minute, was also shown. It was manufactured under licence from the Enclosed Motor Company, Ltd. In this special type of machine the cooling of the motor windings is effected by two fans which are housed at the pulley end of the motor, and which circulate cold air through a series of thin-walled brass tubes, arranged around the circumference of the magnet casing. The motor is thus self-cooled, and all parts, such as terminal boxes and brush gear, are completely encased, access for inspection being given by doors formed in the end shields. Roller bearings of a standard type are fitted to this machine.

A small lighting set shown on the stand comprised a 5-kilowatt 110-volt generator driven by a two-cylinder Gardner 9 brake horse-power petrol-paraffin engine at 1000 revolutions per minute.

In Fig. 62 we show one of the electrically operated worm-driven cargo winches, which was shown at work on the stand. The driving motor carries the control gear on the top, and at the end of the control box the starting handle is fitted. Movement from neutral stop position, either to the right or the left, causes the motor to run in the raising or lowering direction. Between the motor and the gear case there are two brakes, for hand and foot operation respectively. A useful provision is the swinging operators' seat—only part of which is visible in the illustration—which is so designed that when not required it can be neatly stowed beneath the controller casing. The worm gear drive is totally enclosed in an oil-tight casing, and the gear box and main bearings for the warp shaft are supported on a stiff bed-plate of box pattern. The bedplate also serves to encase the contactor gear necessary for the motor controls. Three barrels, a main parallel barrel and two warping ends, are provided. The winch illustrated is designed to lift 3 tons at a speed of 110ft. per minute, 1½ tons at 200ft. per minute, and to run with a light hook at 450ft. per minute. A feature of the winch is its silent operation.

Another type of ship's winch which represents quite a new development in winch design is illustrated in Fig. 63. It has been specially designed to give increased lifting power combined with smaller deck space than is usually taken up by the ordinary steam winch. For this purpose it is fitted with a back gear. The motor is one of a slow-speed type, and it drives the warp shaft through broad machine-cut gearing, running in a closed oil-tight gear case. The gear casing is made in halves to facilitate inspection of the gears. All motor controls are grouped behind the motor and gearing, and they include a foot brake which can be locked in any position by a hand wheel. The actual brake is built into the motor casing. This winch has been designed to lift 5 tons at a speed of 65ft. per minute on the two warp ends. It will also lift 4 tons on the centre barrel at a speed of 90ft. per minute, whilst 2 tons can be lifted at 155ft. per minute, or the winch run with a free hook at 300ft. per minute.

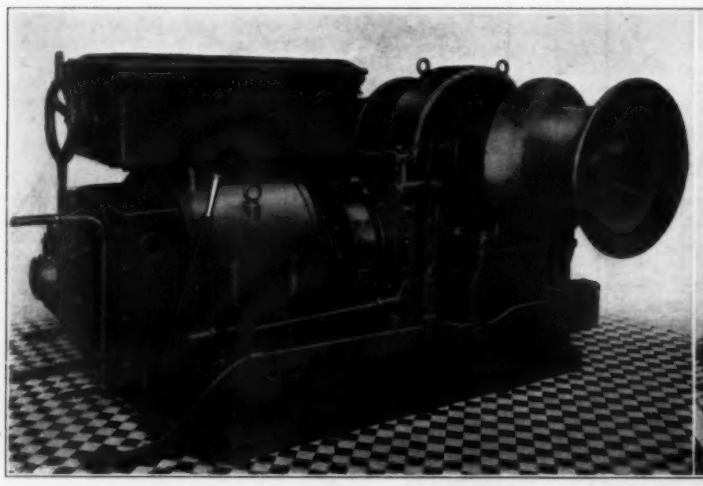


FIG. 62—3-TON WORM-GEARED SHIPS' CARGO WINCH—SUNDERLAND

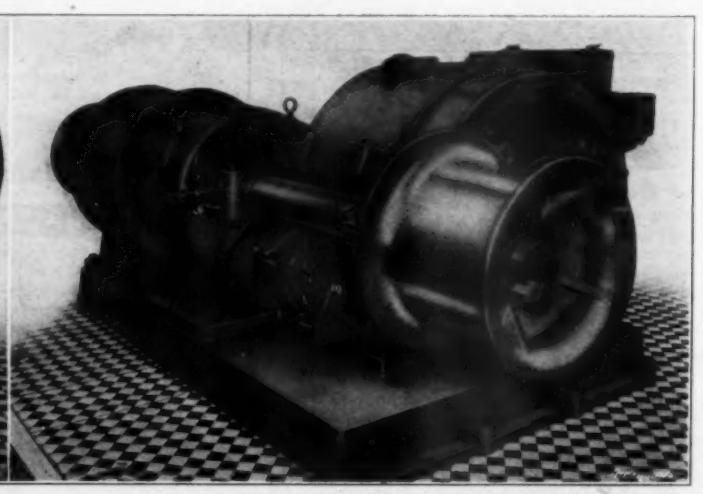


FIG. 63—5-TON BACK-GEARED SHIPS' CARGO WINCH—SUNDERLAND

Other exhibits included the firm's patented form of navigation light indicator, which gives warning when any of the signal lights of the ship fail from any cause, and at the same time cuts in an auxiliary lamp, fed from an independent supply main, which continues alight until the main lamp is replaced or the fault repaired.

A luminous signalling system for stewards was also shown, as well as various patterns of ship's electric fittings for use on deck and in the cabins and machinery spaces.

RYDER AND DAVIDSON.

The "Heliocentric" reduction gear, which was shown on the stand of Ryder and Davidson, Kender-street, New Cross, S.E. 14, is manufactured by that firm under licence from the Central Gear Company, Ltd., of Woolwich-road, Charlton, S.E. 7. This gear,

the invention of Mr. W. C. Pitter, is claimed to give multiple line contact and, in fact, to have half its teeth, or plungers as they may more appropriately be called, continually in contact. The ratio in which the speed is reduced in any one gear is fixed, but there is no restriction as to the ratio which may be selected. Single units have already been made giving a ratio of 60 to 1, but if the overall size can be accommodated, there is no reason, we are informed, why ratios of

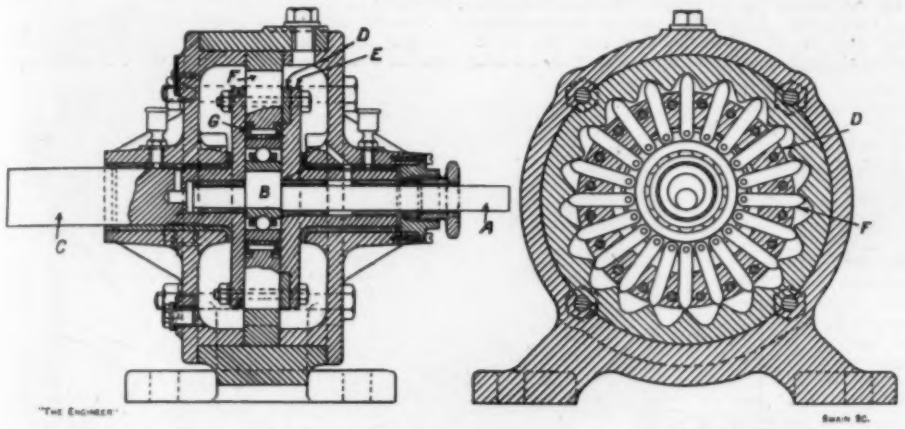


FIG. 64—THE PITTER "HELIOCENTRIC" REDUCTION GEAR—RYDER AND DAVIDSON

500 or 400 to 1 should not be provided in a single unit. By combining two or more units in series, enormous reduction ratios can be reached. On the firm's stand an example of three 27-to-1 units in series was shown, giving a reduction ratio of 20,000 to 1—that is to say, 27^3 to 1. By similar combinations, seven figure ratios could easily be reached without exceeding very modest dimensions.

The gear is illustrated sectionally in Fig. 64. In

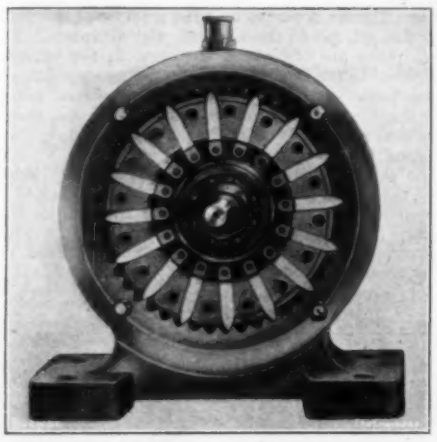


FIG. 65—"HELIOCENTRIC" REDUCTION GEAR

Fig. 65 it is shown with the slow-speed end cover removed, and in Fig. 66 a view is given of the form assumed by the gear when two or more phases are combined in one unit. The high-speed shaft A carries an excentric B surrounded by a ball bearing. Beyond the excentric the high-speed shaft rests within a bearing centralised in the low-speed shaft C. To the flange of the low-speed shaft, a distance ring D and an end plate E are attached. The plate E and its journal

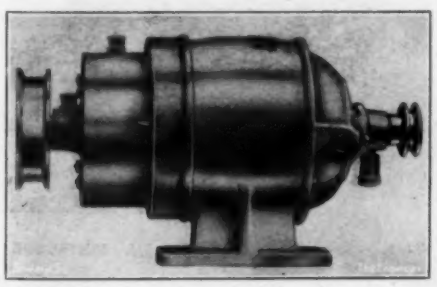


FIG. 66—"HELIOCENTRIC" REDUCTION GEAR

contain two bearings for the high-speed shaft, the journal itself being supported in a bearing in the surrounding casing. The distance ring D is slotted to provide guides for the teeth or plungers F, the ends of which engage with a circular rack fixed inside the casing. The plungers are moved outwards radially as the maximum excentric radius passes beneath their ends, and are retracted clear of the rack teeth by two retaining rings G formed with lips which engage with pins projecting from the ends of the plungers.

Inspection of Fig. 64 will show that while the fixed rack has nineteen hollows, there are twenty plungers engaging with it. In the end section the maximum excentric radius is represented as lying beneath the central topmost plunger. Assuming that the high-speed shaft is rotating anti-clockwise, the plungers to the left are advancing outwards into the rack spaces and the contact which their ends make with the rack teeth will tend to carry the distance ring, and with it the slow-speed shaft, round in the anti-clockwise direction. On the right, the plungers are withdrawing from the rack spaces and are not exercising any driving action. Since each plunger makes one complete reciprocation per revolution of the high-speed shaft, it follows that in the same time the low-speed shaft will make one-nineteenth of a revolution. The gear illustrated in Fig. 64 has therefore a ratio of 19 to 1. By varying the number of plungers and rack teeth different ratios are obtained—Fig. 65 shows a 48 to 1 gear—and by making the slow-speed shaft serve as the high-speed shaft of a second phase, the reduction ratio can be squared, and so on, to any power without greatly adding to the overall length of the gear.

The racks are made of phosphor bronze, and the plungers of case-hardened steel. Although great care is taken to give the rack spaces their correct theoretical profile at the outset the inventor claims that the gear is unique in that any initial inaccuracies are removed by wear, and that the longer the gear is run the more efficient does it become. The casing is filled with oil, which, being kept in constant circulation, promotes smooth and quiet running.

We are unable to state definitely for what purposes the gear has been actually used so far, but we believe that in one instance it has been used to operate a time switch after a machine has made a given high number of revolutions. For that and similar purposes, such as the operation of electric signs, electric drills, &c., it seems well adapted, but it is not intended only for light duties. According to the makers, it is applicable to the driving of machines, such as grinding mills, hand shearing and punching machines, bending and straightening presses, and for use in connection with hoisting tackle, conveyors, ventilating fans and other plant to which it is advantageous or necessary to transmit power at a low rotational speed from a light high-speed motor installed in line with the main drive.

RUSTON AND HORNSBY, LTD.

On the stand of Ruston and Hornsby, Ltd., of Lincoln, there was an example of the Ruston patented Thermax boiler, which we illustrate in Fig. 67. It has been designed, we learn, with the object of producing a boiler which, whilst retaining the reliability of the vertical cross-tube boiler, has the advantage of a decidedly higher efficiency. Prior to placing this new boiler on the market, a Thermax boiler was thoroughly tested in the works over a period of nine months, during which time, with the exception of week-ends, it ran at an overload rating of 30 per cent. After examination at the end of this period it was found to be in good condition.

From the elevation and plan drawing we reproduce in Fig. 67, it will be seen that, instead of large-diameter tubes, tube nests are arranged in a series of tiers, and are so placed that the furnace gases are broken up and circulated round the tubes on their way to the uptake. The inclination of the tubes is stated to facilitate circulation and promote easy steaming, which is further assisted by the large fire-box heating surface. Accessibility has been kept in mind, and in the particular example we illustrate, which is designed for a working pressure of 120 lb. per square inch, twenty-four solid drawn steel tubes of 2in. external diameter are employed. They are expanded into the furnace shell, and opposite each nest are placed hand-hole doors, which permit the tubes to be inspected and cleaned, and at the same time give access to the fire-box shell. Thermax boilers are built in eleven sizes, varying from 6ft. 9in. high and 2ft. 9in. in diameter to 14ft. high and 5ft. 7in. in diameter.

The oil engine exhibits included two Ruston three-cylinder vertical oil engines, coupled to direct-current electric generators, and a small Ruston-Hornsby pumping set, driven by a petrol-paraffin oil engine. The first of the generating sets comprised a three-cylinder engine designed for an output of 45 brake horse-power, when running at a speed of 450 revolutions per minute. It drove a 27 to 28-kilowatt dynamo constructed by the Sunderland Forge and Engineering Company, Ltd. The second example of a power and lighting set was a 90 brake horse-power three-cylinder oil engine driving through a flexible coupling a 60-kilowatt generator built by the Electric Construction Company, Ltd. The engines were representative of the firm's latest practice, and were capable of running on crude oils or heavy Diesel oils. Using such fuels, consumptions of the order of 0·45 lb. per brake horse-power hour are obtained with the smaller engines, whilst in the case of the larger units fuel consumptions as low as 0·38 lb. of oil per brake horse-power hour have, we are informed, been obtained.

The pumping unit above referred to consisted of a paraffin-petrol engine coupled through gearing to a single ram vertical pump designed for an output of

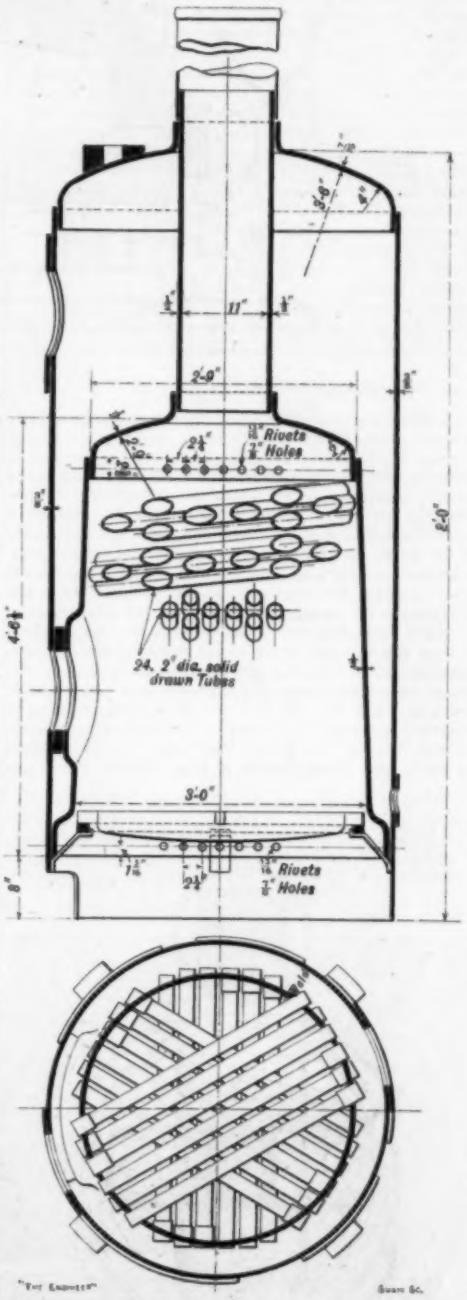


FIG. 67—THE "THERMAX" BOILER—RUSTON & HORNSBY

1700 gallons of water per hour against a total head of 100ft. The set was so designed that the pump could be thrown out of gear and so that, if required, the engine could be employed for driving other machinery.

BOLTON'S SUPERHEATERS.

The Field tube superheater made by Bolton's Superheater and Pipe Works, Ltd., Stockport, is well known. The latest development by this firm is the Bolton-Gray high superheat sectional superheater, in which the method of attaching the elements to the headers is a special feature. This is effected by flanged spigot and socket type joints held by four standard bolts and the joint is made across the whole face of the flange. The element joints on the saturated and superheat headers are secured separately. This superheater is constructed throughout of wrought steel and is adaptable to all kinds of boilers, both water-tube and Lancashire. When working with the

latter final temperatures up to 750 deg. Fah. are claimed to be obtainable. A sectional view of one of the elements was published in The Engineer of October 17th, in connection with the Textile Exhibition which was held in Manchester recently.

Ed. Bennis and Co., Ltd.

We have already referred to the fact that the furnace arch shown by the Liptak Company was built up over a stoker by Edward Bennis and Co., Ltd., of 28, Victoria-street, S.W., and we are now able to give an illustration—in Fig. 68—of the stoker itself.

The stoker, it will be seen, is of the chain grate type, but is differentiated from many others of that class by the arrangements made for distributing the forced draught. It is intended, primarily, for the consumption of low-grade fuels, which require a careful gradation of the draught over various zones of the grate, and the space below the fire bars is consequently divided up into several compartments—as shown in the drawing. All these compartments are provided with a supply of forced draught from a common duct, and each is fitted with an inlet damper, so that the local intensity of the draught can be regulated at will. The draught is supplied by means of a small, high-speed fan, which produces a considerable pressure, and the air it delivers is used in a large injector, set near the boiler, to suck in atmospheric air and drive it forward to the furnace. The natural result of this arrangement is that the air ducts can be reduced in size very considerably, as compared with the usual low-pressure system, and the fan can be put down in any convenient central position.

A certain proportion of the ashes from the fire must, of course, riddle through the chain grate and would ultimately choke up the draught passages if there were no outlet for them. The floors of the forced draught compartments are consequently perforated, and these perforations are closed by a comb-like casting. By sliding the comb, so that its spaces coincide with the holes in the floor, the ashes can be discharged through the lower part of the grate into the ashpit below.

The chain grate itself is of the maker's deep type, with halved links, and is specially suitable for use in connection with a supply of pre-heated air. It is driven by a totally enclosed, worm reduction gear running in an oil bath, which has a safety release gear to prevent the machine being damaged if an abnormal resistance happens to develop in the furnace. This gear includes six changes of speed to accommodate various rates of combustion.

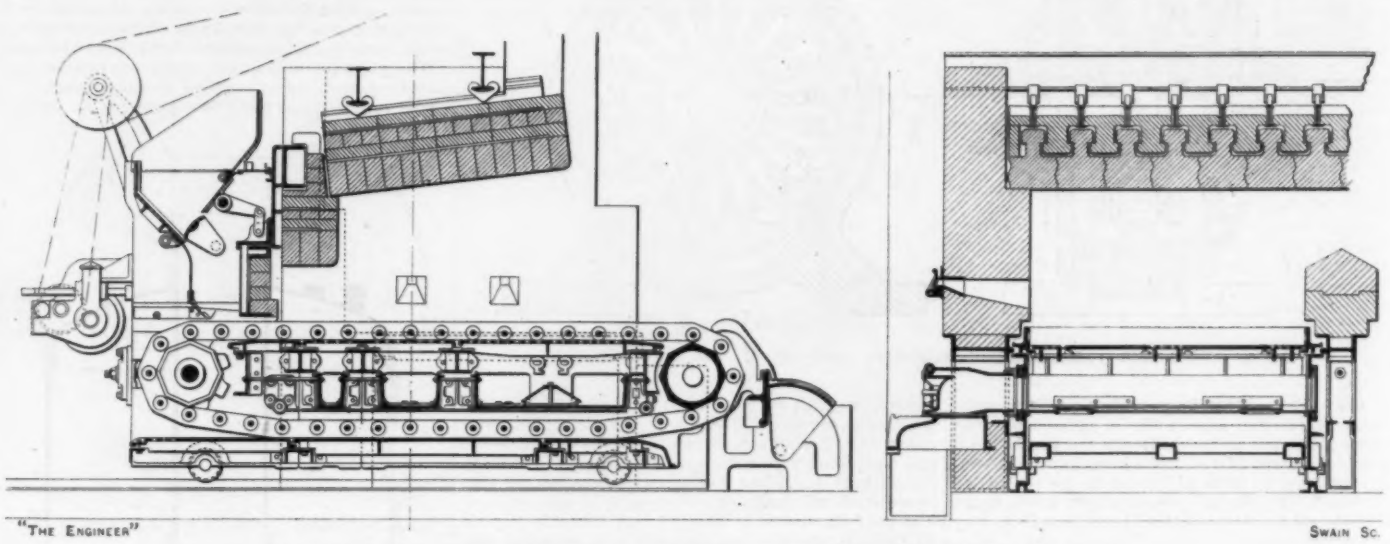


FIG. 68—DEEP-TYPE CHAIN GRATE STOKER ARRANGED FOR USE WITH PRE-HEATED AIR—BENNIS

Holman Brothers, Ltd.

A notable exhibit on the stand of Holman Brothers, Ltd., Camborne, Cornwall, was a four-cylinder example of Dr. H. S. Hele-Shaw and Mr. T. E. Beacham's new form of air compressor. This machine represents a development of the Hele-Shaw rotary pump produced several years ago and since largely used for a variety of purposes. It had been realised for some time that the mechanism of that pump could also be adopted in an air compressor if certain practical difficulties, connected with the lubrication of the parts and the sealing of the valve, could be overcome. The method of overcoming these difficulties applied in the air compressor exhibited was worked out by Mr. T. E. Beacham. It has, it is claimed, proved completely successful, and as a result it has been found possible to construct air compressors to run continuously at speeds which are believed to have been regarded hitherto as impracticable.

The compressor is illustrated in Figs. 69 and 70. The two low-pressure cylinders C C and the two high-pressure cylinders D D are cast in one unit, which is rotated by the driving shaft. The bearing about which the cylinder casting rotates is provided by a central valve E fixed at one end to the casing and at the other supported in a ball bearing centralised within the end of the driving shaft. Each piston has two gudgeon pins which extend through slots cut partially down the cylinder walls. External to the cylinder walls the pins are furnished with bushed rollers. These rollers rest within floating races or rings F mounted to rotate freely on ball bearings about excentrics forming part of the casing or of its end cover and having an excentricity equal to half the piston stroke. The floating rings are not attached in any way either to the casing or the cylinder casting. As the cylinder casting rotates the floating rings and their ball bearings act during one half of a revolution merely as intermediaries for the transmission of the pressure between the gudgeon pin rollers and the excentrics. During the other half of the revolution pressure is exerted on the rollers by the outer flanges of the floating rings. The rotation of the cylinder casting, therefore, results in the radial reciprocation of the pistons, the respective reciprocations being equal in amount but displaced as regards time.

Free air enters the system at A through a gauze strainer, and passing through a Venturi contraction reaches a chamber surrounding the neck of the central valve. Thence it passes into the interior of the valve and through ports therein into the cylinders. The valve ports are uncovered by ports in the cylinder bottoms. In the case of the low-pressure cylinders the latter ports are in the form of truncated cones. Corresponding truncated extensions on the piston faces are provided to enter the ports with the object of reducing the clearance volume.

The air discharged from the low-pressure cylinders is led through a passage inside the central valve to an intercooler I, from which it returns through another passage in the central valve to ports opening when uncovered into the high-pressure cylinders. From the high-pressure cylinders the air flows through the final cooler Y and is discharged up the pipe B, through an oil eliminator and out at O. The two coolers and the central valve are provided with circulating water passages W.

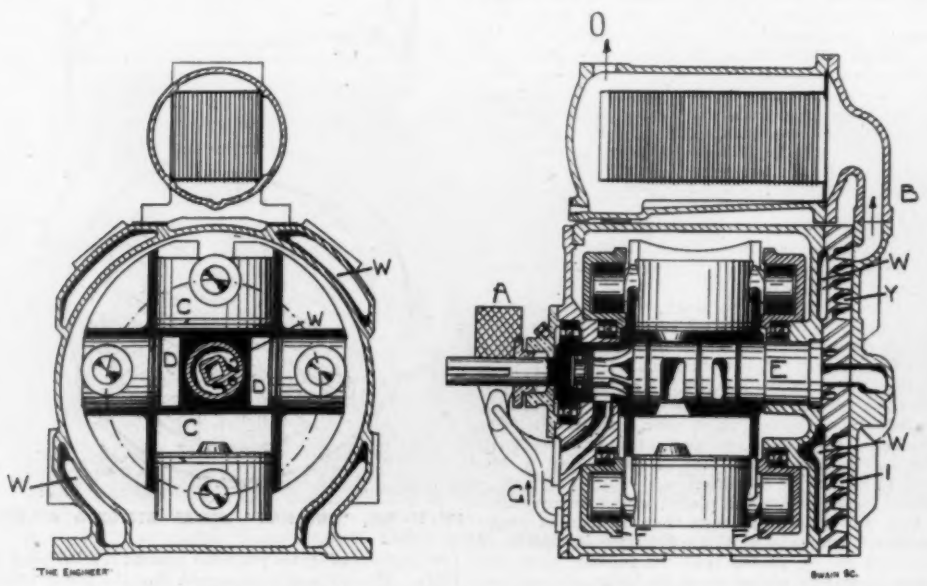


FIG. 69—HELE-SHAW-BEACHAM FOUR-CYLINDER AIR COMPRESSOR—HOLMAN BROTHERS

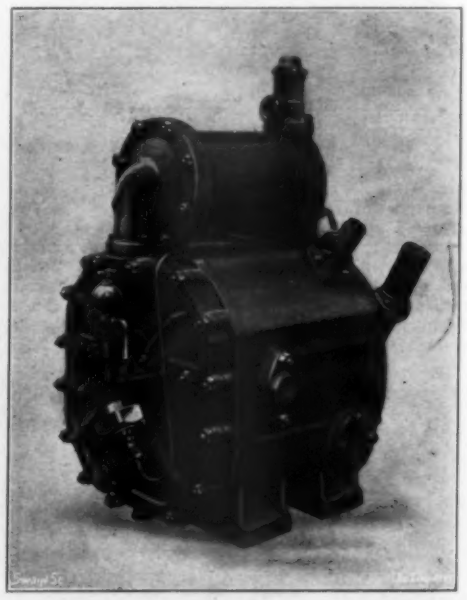


FIG. 70—HELE-SHAW-BEACHAM AIR COMPRESSOR

The feature of the invention is the saturation of the incoming air with oil. This oil is supplied by the pipe G entering the air inlet at the Venturi contraction and drawing its supply from the foot of the casing. The oil remains in the air during the two compression stages and the two cooling periods and is removed by the eliminator just before the air is discharged. This eliminator consists of a baffle plate followed by a nest of about 800 vertical wires, each $\frac{1}{16}$in. in diameter. The oil removed from the air is under the final air pressure and is forced down a small-

bore pipe, which throttles its pressure to about 30 lb., into the central valve, along which a bore-hole is provided for its reception. From this hole the oil flows out into three sealing grooves between and beyond the low and high-pressure ports. Additional passages are provided in order to secure the effective lubrication of the gudgeon pins, &c. The oil returns to the sump by leakage and is thence drawn up the pipe G by the Venturi action to enter again upon the cycle of its course.

It is of interest to note that a non-return valve has to be fitted in the discharge in order to prevent the machine, should it be stopped under load, from reversing and draining the receiver. The machine illustrated, when run at 1000 revolutions per minute, is, we understand, capable of compressing 75 cubic feet of air per minute to a pressure of 80 lb. to 100 lb. Some much larger examples to deal with up to 480 cubic feet at 750 revolutions per minute are, we gather, being manufactured, while at the other end of the scale we notice that a 14ft. compressor running at 3000 revolutions per minute has been supplied to the Royal Air Force for intermittent service. It is claimed for this type of compressor that, in addition to its high-speed qualification, it is exceptionally compact, exhibits no vibration, possesses a very high volumteric efficiency, and delivers the air at a low temperature.

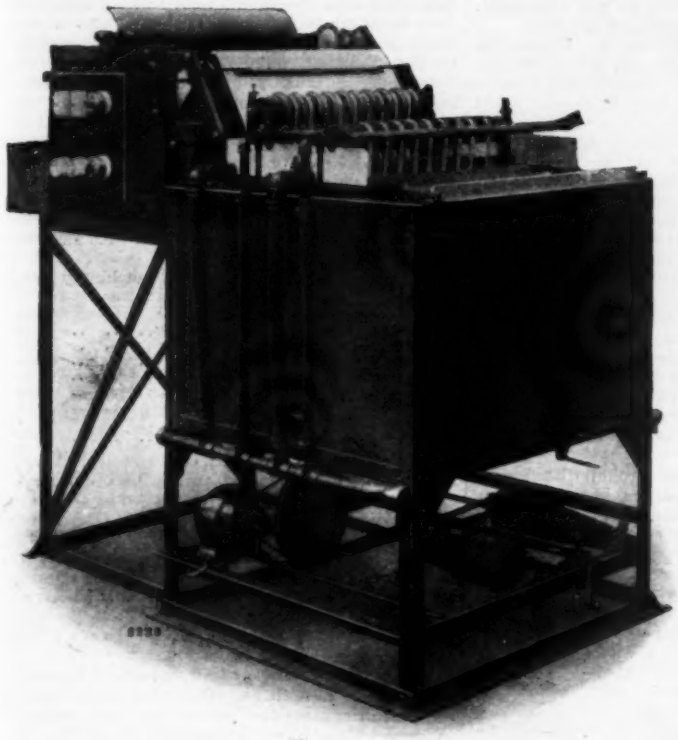


FIG. 71—LUCIGRAPH WASHING AND DRYING MACHINE

ALFRED HERBERT, LTD.

Most of our readers are already familiar with the Lucigraph photographic copying machine, which was shown by Alfred Herbert, Ltd., Coventry. By its means photographic copies of drawings, tracings, or documents are made directly on sensitised paper. A reversing prism in front of the lens allows the object to be copied to be placed horizontally. The machine "exposes" the print, cuts it off from the roll, and develops and fixes it, while any required amount of reduction or enlargement can be obtained within the limits of the machine. The Lucigraph does not supersede the blue printing machine, but supplements it. If good, clear tracings are available it is less costly to make blue prints than Lucigraph prints, but the Lucigraph enables copies of opaque documents, pages of books, &c., to be made. An improved form of the washing and drying apparatus has recently been introduced by the makers. A view of this machine is given in Fig. 71. The moving rollers are driven by means of a small self-contained electric motor through a worm reduction gear. The washing portion is composed of inner and outer tanks made of galvanised iron, and before leaving this part of the machine a squeegee roller removes the surface moisture from the print. The drying portion comprises a drying drum of mild steel sheet covered with fabric and a main conveyor band of cotton duck. This drum is electrically heated, and, having a large drying surface, enables prints to be dried in one revolution. When the work has been fed into the machine it may be left to take care of itself. It is conveyed in a zigzag course through the washing tanks by means of a belt conveyor, being finally delivered into a box at the back of the machine.

L. GARDNER AND SONS, LTD.

The firm of L. Gardner and Sons, Ltd., of Patricroft, Manchester, and 115, Queen Victoria-street, London, showed a representative group of industrial and marine oil engines. A prominent exhibit on the stand consisted of a four-cylinder marine type oil engine, designed for an output of 140 brake horse-power when running at a normal speed of 320 revolutions per minute. Engines of this type, we learned, are built in a wide range of sizes up to 300 brake horse-power. The model shown was fitted with a clutch and direct reversing gear, and both the circulating water pump and the bilge pumps were engine driven. The type of engine shown is used both for marine propulsion and for auxiliary work. A smaller engine of a similar design was also displayed. It was a 12 horse-power model running at a speed of 550 revotions, and similar engines are built up to four-cylinder units of 48 brake horse-power. Another small engine of neat design which we have chosen for illustration is the single-cylinder 3½ brake horse-power petrol-paraffin lighting set—shown in Fig. 72. The engine and generator are mounted, it will be seen, on a common bed-plate, and a large fly-wheel, giving an equal turning moment and close speed regulation, is fitted. The cylinder casing is of box form, and is particularly robust in design. In the illustration we reproduce the gear casing is removed, so that details of the valve gear and the magneto drive can be seen. Similar lighting sets are built with engine outputs up to 12½ brake horse-power.

Another petrol-paraffin oil engine unit which was displayed on the stand was a 38 brake horse-power four-cylinder engine, designed for 800 revolutions per minute normal running speed. It was coupled to a Gardner transmission reversing gear. This engine is one of the largest of its particular type, which is, we understand, largely used for the propulsion of yachts, tugs, lifeboats and other small motor craft. Without the reversing gear it may equally well be employed for pumping, lighting and other industrial services. The larger cold-starting oil engines of the horizontal type which form a special branch of the firm's manufactures, were represented by the 44 to 47 brake horse-power model—illustrated in Fig. 73. This particular engine is designed for a speed of 230 revolutions per minute, and it operates on the four-stroke cycle, with solid injection. A centrifugal type governor controls the fuel pump stroke and delivers the precise amount of oil required for a given load to the engine cylinder. The timing is so arranged that the point of injection relative to the combustion stroke is unchanged. The Gardner combustion chamber is of spherical form, and is completely water-cooled. A compressed air starting system of the piston charging type is fitted. The engine is designed to use heavy residual oils ranging from refined petroleum up to Taracan oil of 0·95 specific gravity. Fuel consumptions of 0·42 lb. to 0·44 lb. of oil per brake horse-power have been obtained. The amount of lubricating oil required for this engine is, we are informed, less than one-fortieth of the fuel consumption.

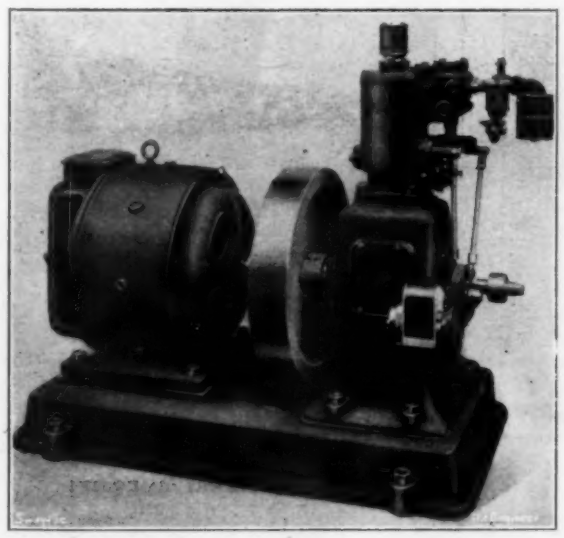


FIG. 72—SMALL LIGHTING SET—GARDNER

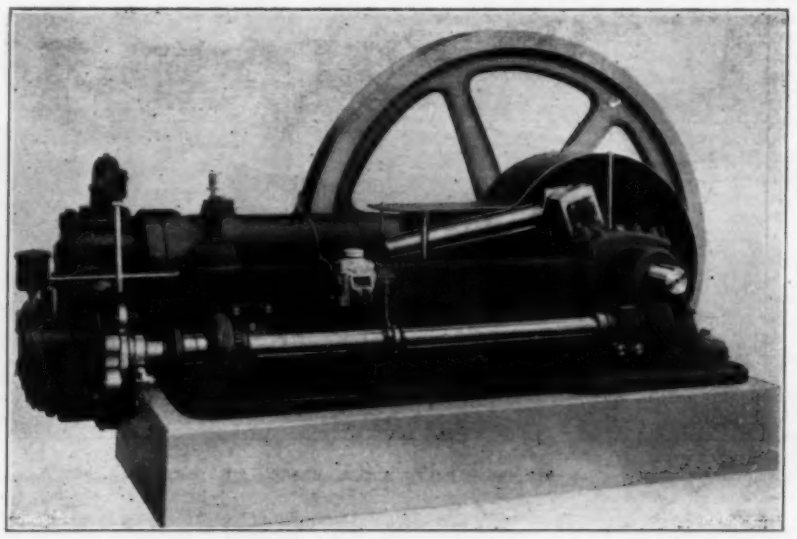


FIG. 73—47 B.H.P. COLD STARTING OIL ENGINE—GARDNER

MUSGRAVE AND SONS, LTD.

Musgrave and Sons, Ltd., of Bolton, were represented by a collection of their appliances for steam condensation purposes, including the steam ejector, centrifugal condensate extraction pumps, ejector air pumps, and an instrument called an ejector augmenter. The last-mentioned exhibit was specially designed for marine purposes in conjunction with the ordinary type of reciprocating pump. It enables a more perfect vacuum to be maintained in the condenser without the necessity of increasing the size of existing reciprocating air pumps and at the expense only of exhaust steam, as it operates at a pressure of but 5 lb. per square inch. The centrifugal pumps shown are made in a number of sizes and have been specially designed for extraction purposes on vacuum plant where dry air pumps are used.

LACY-HULBERT AND CO., LTD.

In our description of the Lacy-Hulbert portable air compressor in last week's issue we stated that the machine was driven by a 17 horse-power petrol engine. The makers have since informed us that, while the compressor requires only about 17 horse-power to drive it, the engine actually used is of 28 horse-power capacity. This size of engine has been fitted in order to provide a good margin of power and hence to ensure satisfactory running at full load for long periods without fear of overheating or undue wear and tear.

The Swedish-American Motor Liner Gripsholm.

No. III.*

In our two previous articles of November 27th and December 4th respectively, illustrated descriptions of the new motor liner Gripsholm and her main propelling engines were given. In the present article we propose to deal briefly with the auxiliary engine-room machinery, which includes the Diesel engine-driven electric generator sets and air compressor sets, service pumps, heating boilers, and boiler auxiliaries.

The auxiliary engine-room is forward of the main

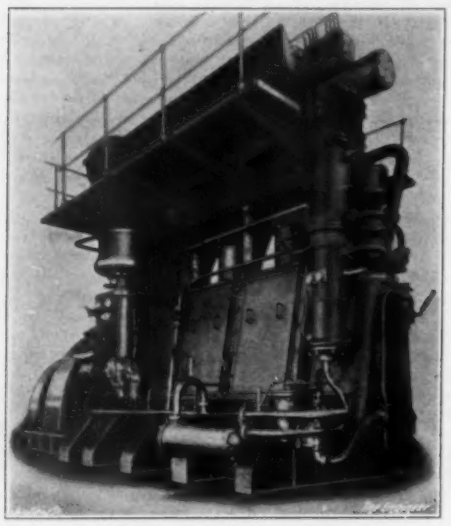


FIG. 6—330 KW. GENERATING SET

engine-room and is separated from it by a main bulkhead, access between the two rooms being given by two water-tight doors. The main generator and air compressor sets are grouped in threes, the centre engine coinciding with the centre line of the ship, so that ample space is left in the engine-room wings for the pumps and the other auxiliary machinery. Three electric generator sets are placed near to the after bulkhead, which carries the switchboard gallery —see Figs. 10 and 11 on page 640. The air compressing sets are placed forward and in the recess the heating boilers are placed. The illustrations which we reproduce on page 640 are typical views in the auxiliary engine-room, and Figs. 6 and 7 illustrate the electric generator sets and the air compressor sets respectively. Referring to Fig. 6, it will be seen that the

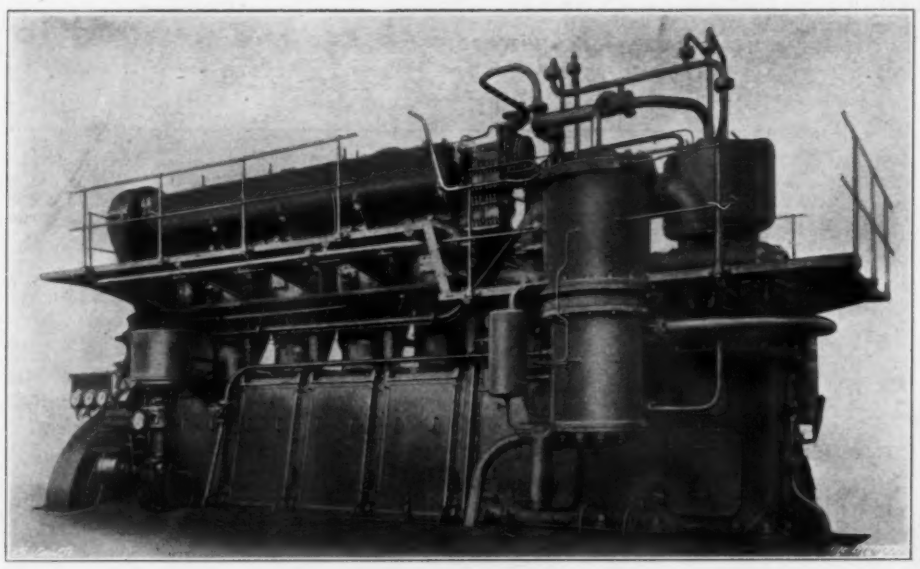


FIG. 7—700 B.H.P. DIESEL-DRIVEN AIR COMPRESSOR SET

engines driving the electric generating sets are of the standard Burmeister and Wain pattern with square cylinder covers and the other characteristic features of the firm's new design. They are each designed for a continuous output of 500 brake horse-power when running at the moderately low speed of 200 revolutions per minute. Each engine is coupled direct to a 330-kilowatt, 220-volt Thrige direct-current generator. In normal service at sea two generating sets will be, we are given to understand, more than sufficient to supply the lighting and power load of the ship.

The view reproduced in Fig. 11 on page 640 shows the switchboard supplied by Whipp and Bourne, of Castleton, Manchester. The three centre panels are the generator panels, whilst to the left are panels for the winch motors, thermotank and heating, and the lighting and cooking services. To the right of the three centre panels are six panels with different circuits for the engine-room auxiliary machinery and pumps. An interesting feature of the pump controls is a pilot light which remains burning as long as the particular pump served is in operation. Any failure is thus made at once apparent to the attendant. The circuit voltage is 220 throughout the ship.

The engines which drive the three air compressing sets are each four-cylinder units, and one of them is illustrated in engraving Fig. 7. Each engine is rated at 700 brake horse-power at a normal running speed at 170 revolutions per minute, while the air compressors are twin inverted three-stage machines with large intercoolers. Each of the air compressor engines is furnished with an electric turning motor.

One air compressor has sufficient capacity to supply compressed air for one main engine, and consequently only two sets will be required in operation when the vessel is under way, whereas the third set will serve as a standby unit. The compressors also act as manœuvring compressors and supply the air required when entering harbour or at other times when the engines require to be started and stopped frequently. The four main starting receivers are of cylindrical form and are placed in pairs on either side of the auxiliary engine-room. There are also two other air compressing sets, a small electrically driven three-stage Burmeister and Wain air compressor, and a still smaller emergency set.

The auxiliary Diesel engines are all fitted with engine-driven lubricating oil pumps, but the cooling water for the cylinder covers and jackets is furnished by two electrically driven salt water pumps running at a speed of 1000 revolutions per minute. Only one pump is required in actual service and the other serves as a standby, arrangements being made for these pumps to act as fire or sanitary pumps at about 14 lb. per square inch pressure if so required.

Referring to the lubricating oil and the fuel oil supply circuits, we may mention that four De Laval centrifugal separators are fitted in the auxiliary engine-room. Each separator is designed to deal with 120 gallons of oil per hour, and the arrangements are such that oil can be continuously purified and supplied to any of the auxiliary engines or compressors. As regards fuel, two settling tanks are arranged in the engine-room hatch, each of which carries a twelve hours' supply of fuel oil. Oil from the settling tanks is passed through double filters to the engines. The oil fuel supply pump and transfer pumps are similar to those used for the main engines and are designed for 150 tons of oil fuel per hour.

Service Pumps and Heating Boilers.

The two views Figs. 8 and 9 reproduced on page 640 show main groups of service pumps. At the after end of the engine-room are arranged three fresh water pumps which are of the Drysdale Centrex type, each designed for an output of 75 tons of water per hour. Similar pumps by the same makers are used for the sanitary and general services, four Drysdale Centrex pumps, each of 200 tons capacity per hour, being installed. The main ballast and bilge pumps were supplied by G. and J. Weir, Ltd., of Cathcart, and comprise two 250-ton motor-driven ballast pumps and two 150-ton electrically driven bilge pumps. Other pumps shown in the foreground of Fig. 8 are the fuel transfer pumps already mentioned.

There are two cylindrical multitubular boilers made by Sir W. G. Armstrong, Whitworth and Co., Ltd., each of which has 1320 square feet of heating surface, the furnaces being fitted with Clyde oil fuel burners working on the closed stokehold system. The necessary air for combustion is supplied by a motor driven fan placed in the auxiliary engine-room, whilst the oil burning apparatus is arranged in two self-contained units. A condenser with 500 square feet of surface and independent air and circulating pumps is fitted for the steam drainage system connected with the thermotank heating installation. Two Weir steam-driven feed pumps and a 30-ton evaporator complete the boiler-room auxiliaries. In the auxiliary engine-room is a complete set of Pneumacator tank gauges supplied by Kelvin, Bottomley and Baird, Ltd., of Glasgow. This equipment serves twenty-eight oil fuel tanks and it is fitted with alarm devices which notify the attendant when the tanks are approaching a full condition. Reference may also be made to the well-planned workshops arranged one in the main engine-room and the other in the auxiliary engine-room. Each workshop is large in size and is equipped with electrically driven machine tools.

The following are some of the machinery weights of the installation :—

	Tons.
Two main engines	1030
Three Diesel-electric generators	210
Three Diesel compressor sets	260
Engine-room Diesel auxiliaries	60
Air receiver, silencer, &c.	120
Spare parts and tools	70
Approximate total weight	1750

The motor liner Gripsholm, of the Swedish-American Line, marks a further step in marine oil engine progress and one which has been achieved by the friendly co-operation of the shipbuilders, Sir W. G. Armstrong, Whitworth and Co., Ltd., and the designers and builders of the engines, Messrs. Burmeister and Wain, of Copenhagen. The Gripsholm left Gothenburg on November 21st and she arrived in New York on the 30th of the same month, thus completing her maiden voyage in a little over the scheduled time of about eight and a-half days.

In concluding these articles, we would express our indebtedness to both the owners and the builders for the particulars supplied and the facilities given to us to inspect the ship, whilst mention should be made of the excellent interior photographs of the main engines and auxiliary machinery, which were specially taken for the builders by Bedford, Lemere and Co., London.

* No. II. appeared December 4th.

Timothy Hackworth and Shildon.

The part that Shildon played in the coming of the locomotive steam engine is well known to all who follow the history of that fascinating subject. But Shildon is a little grieved that it was not permitted to play a more

STATUE OF TIMOTHY HACKWORTH

important part in the Railway Centenary Celebrations, and on Saturday last, December 5th, it held a celebration of its own, when a tablet on the Masons Arms railway offices and a bronze statue of Timothy Hackworth were unveiled. The tablet, which contains the following words, was provided by the London and North-Eastern Railway Company :—"From Shildon, near this site, the Stockton and Darlington Railway Company, on the 27th September, 1825, ran the first passenger train drawn by a steam engine." The statue, which has been erected by public subscription, is illustrated herewith. It cost about £800, and to Mr. Middleton Turnbull and Mr. F. F. Bainbridge every credit is due for the energy they displayed in the execution of a scheme to do honour to a famous engineer.

The Public Works, Roads and Transport Exhibition.

No. III.*

THE principal exhibit on the stand of Millars' Machinery Company, Ltd., of Pinner's Hall, London, E.C. 2, was a portable 8 to 10 tons per hour asphalt plant. This plant, though obviously of rigid and substantial design, is readily portable on its own wheels, as is shown by the fact that it was taken from the Bishop's Stortford works of the company to the Royal Agricultural Hall, and was erected on the stand, ready to run, in twelve hours. It embodies many special features, which are the outcome of the company's extensive experience in the building and operation of asphalt plant; the firm, we may say, began the manufacture of an all-British machine between three and four years ago. The feature to which attention is drawn as being of first importance is the high thermal efficiency of the drying and heating arrangements, which include the complete lining of the furnace and dryer casing with non-conducting material, which is claimed practically to eliminate radiation losses. The rotary drying drum, which is almost entirely enclosed in the furnace casing, is also fitted with specially designed lifting bars that are said to cascade the material being treated through the hot gases far more efficiently than the usual angle iron lifters. A plant identical with that exhibited is shown in Fig. 18.

On being discharged from the drum, the dried and heated materials pass up a hot elevator and, at will, can be discharged (*a*) into a screen for separating fine and coarse materials and thence to storage bins; or (*b*) by setting a by-pass, direct into the storage bins; or (*c*) alternatively, they can be diverted to a return chute which takes them back to the feed end of the chute. This latter provision is distinctly useful, because by means of it the operator can control the quantity and the temperature of the material going into his storage bins. For example, the first thing in the morning on starting up with cold and wet material, the latter can be returned by the chute and passed again and again through the heater until the correct temperature is recorded. The return chute is then closed and the material delivered into the storage bins either direct or *viâ* the screens. This procedure eliminates the necessity of dropping several loads of over, or under, heated material through the mixer and of removing it by hand from under the platform.

The return chute, it is pointed out, has another useful function in that, as it is always necessary, in practice, to close down the mixing plant at least 1½ hours before work ceases on the road, because the operations of spreading and rolling have to be carried out after the asphalt has been delivered from the mixer, the dryer can still be employed usefully. When at 4 p.m., say, the last load of mixture leaves the plant for the road, the furnace and dryer are still hot, and that store of heat would be wasted if operations were entirely stopped. By diverting the heated material to the return chute, the plant can be run till, say, 5.30 p.m., presumably without further firing, and the material dried and heated during the intervening hour and a half may be dumped at the feed end of the plant ready for the next morning. By covering the heap with a tarpaulin it remains dry, and on the following day it can be fed into the machine as and when required by means of a two-way valve, which is operated from the mixer platform.

The makers inform us that one of their 8-10-ton plants operating in Holland has been turning out 110 tons of "Topeka" mix as a daily average over a long period on a fuel consumption of less than 0·6 per cent. of fuel consumed of weight of material treated.

On the Millars stand there were also a 4 L "Jaeger" concrete mixer, which has a batch capacity of 7 cubic feet unmixed and of 4½ cubic feet mixed, and an average daily output of from 40 to 50 cubic yards; and a "Tructractor" for the handling of materials, such as concrete, sand, stone, asnes, &c., which is fitted with an automatic end or side dumping body. With this vehicle the load is dumped and the hopper recovered by the driver without dismounting, and it has a hopper capacity of 30 cubic feet. There was also a concrete cart with steel hoppers and a single diaphragm pump, which is a portable self-contained unit, gear-driven from a petrol engine. It is intended for pumping water from excavations or trenches, and standard models have a capacity of from 6000 and 12,000 gallons per hour.

At nearly every Exhibition at which it has a stand, Winget (1924), Ltd., of Winget House, Grosvenor-gardens, London, S.W. 1, manages to have something new to show. On the present occasion it had a fine display, among which were several novelties, but before going on to speak of them, we may mention first a beautifully made working model of one of this firm's asphalt mixing plants, such as we illustrated and described in our issue of March 23rd, 1923. The machinery of the model was being revolved and an excellent idea of a full-sized plant in operation was conveyed to the onlooker.

The novelties chiefly consist of improvements and developments of previously invented machines, these developments all tending to make the machines more efficient and more easily operated. One quite simple thing, really, which has recently been patented has made a very considerable improvement. It is in connection with the mould box for making concrete blocks and slabs, and it was shown applied to several machines. By hinging the two end doors to the back door, and the front door to the base plate, and by connecting all of them together by means of a simple but ingenious link motion, the box can be opened or closed by the aid of one single handle. By this device the speed of operation has been materially increased, and it is no longer necessary to fit the pallet into the mould accurately. It is simply put on the base and the closing of the mould causes it to take up its proper position.

Another improvement which we noticed was the addition to the No. 3 automatic slab-making machine of a device to prevent the head from being operated until it is directly over the centre of the mould box. The device is in the form of a lock on the clutch pedal, which is only released so that the clutch can be disengaged when the ram is in the correct operating position.

Still another improvement was to be seen in the firm's No. 2 pressure block-making machine, in which the pressure is applied by a hand wheel and toggle arrangement which is so designed that the further turning of the hand wheel beyond a certain point only tends to relieve the pressure, so that it is impossible for the operator to injure the mechanism. That particular attribute is, of course, not new. We have described it in connection with earlier models of the same type of machine. In what is known as the 1926 model, however, there have been two innovations, as well as the new type of mould box. They are (*a*) that by the addition of a specially constructed worm-driven head the pressure that can be applied to the block has been increased to 10 tons; and (*b*) that the hand wheel is now placed at the side instead of at the back of the machine, which permits of greater speed of operation.

The latest addition to the firm's crushing and screening plant is a combined unit for dealing with clinker. It was shown in operation. The clinker is first charged on to a grizzly or jigging screen, which lets through all material of ¾in. and under, and passes on what is rejected to a set of crushing rolls. The small material is thus prevented from choking the rolls, but is led to the discharge from the latter, so that the sifted material is added to the crushed material coming from the rolls. The output is stated to vary from 3 to 10 cubic yards per hour between the two sizes of rolls, namely the "O O" and the "O O Junior," according to the type of material dealt with.

This firm's semi-spiral wet concrete mixer, 1926 model, of which a 4½ cubic foot—mixed—size was exhibited, also embodied some new features. It has a large diameter, but narrow width, drum, and it is claimed that (*a*) the materials are mixed together under a maximum of agitation; (*b*) the materials are confined in their fall over the blade to a limited width, but are given a very big fall, which prevents the separation of the fine from the coarse particles and ensures a perfect pouring of the whole of the ingredients into the centre of the agitator; (*c*) a much larger opening at the feeding side of the drum allows the material to run freely from the elevating hopper into the deep diameter of the revolving agitator, so that there is no waiting for the material to run out of the hopper; and (*d*) a large diameter, narrow drum permits of the discharge chute being introduced into the heart of the mix with instantaneous effect.

The output of this machine is from 4 to 6 cubic yards per hour. Its overall measurements are:—Length, 8ft. 9in.; breadth, skip up, 5ft. 10in., skip down, 7ft. 3in.; height, 7ft. 9in. The height from the ground to the discharge chute is 2ft. 5in. Its weight is 36½ cwt., and it takes a 3½ horse-power engine to drive it.

Reavell and Co., Ltd., of Ipswich, showed, amongst other things, portable air compressors of various types. One of them, a particularly neat little plant, is illustrated in Fig. 19. It was first produced to meet the requirements of the engineers of a large tramway undertaking, for a portable plant which could take its power from overhead trolley wires and supply sufficient air for operating a concrete breaker, so as to enable track repairs to be effected as quickly as possible with a minimum of interference with the traffic. We gather that the first set supplied was found to be so effective that the tramway undertaking, for which the original machine was designed, now has over thirty sets of a similar kind in constant use. The work on which they are employed is the supplying of compressed air to breakers for cutting away the concrete in which the tram rails are embedded, so that defective lengths can be removed or a sunken piece of track raised and levelled. The makers claim that, with the help of it, a single operator can do the work of a gang of six or seven men with hammer and chisel, and that, not only is the work done more effectively, but interference with the running of the tramcars is much reduced. They assure us that in many cases it is possible, by the use of this machine, to open up a length of track each day, and make everything good by nightfall, which, as they point out, would be im-

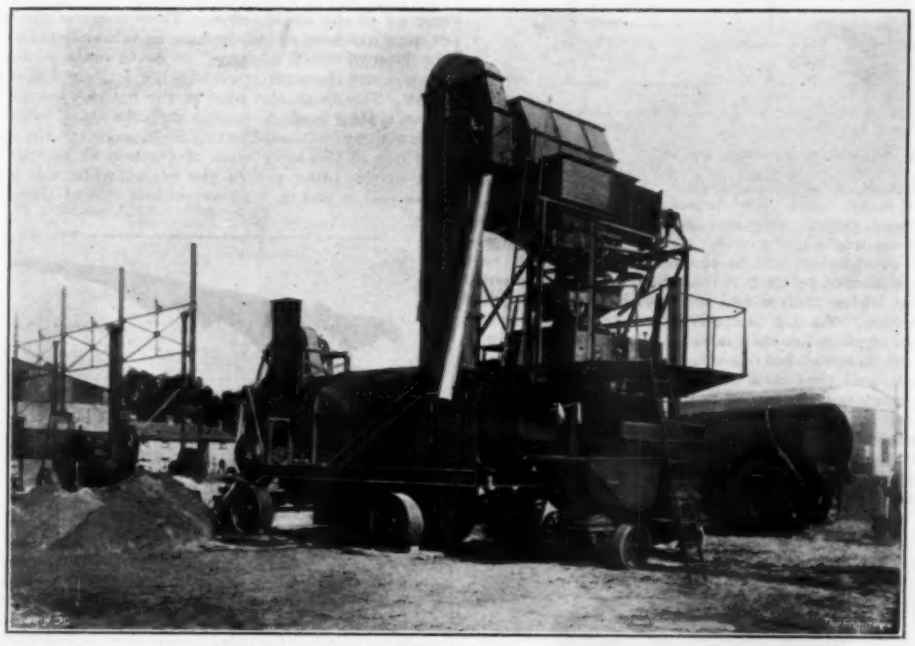


FIG. 18—8-10 TON-PER-HOUR ASPHALT PLANT—MILLARS' MACHINERY COMPANY

* No. II. appeared December 4th.

possible if the old-fashioned hand method were employed.

In the design of the plant, much thought was exercised to produce an entirely foolproof unit, which, in addition to being efficient and reliable, would require a minimum of attention and could be operated by the navvy using the concrete breaker. It comprises a two-cylinder unjacketed compressor driven through gears by a totally enclosed motor, which is specially arranged for bolting up to the compressor, so as to form a complete unit in which the gearing is enclosed. The composite unit is mounted above a small air receiver by means of brackets, which also carry four steel wheels, two of which are on a swivelling axle. Two connections for pneumatic hose are made to the receiver, for, when working in soft concrete, the plant will keep two breakers supplied with air, though actually it is intended to furnish an ample volume of air for one breaker working under the compressor. There is also a fixed jockey pulley mounted on the frame, and the belt tension can be adjusted by means of slide rails and tightening screws fitted to the platform on the lines of the ordinary belt-tightening device. The actual combined plant shown will, we are informed, run a heavy concrete breaker continuously, or it will run two breakers on light duty, while the larger compressor will supply sufficient air for two heavy concrete breakers. For work abroad jack hammers may be substituted for concrete breakers and the plant is, Messrs. Reavell point out, extremely useful for penetrating country which has only tracks or may be without roads at all. Unjacketed compressors are recommended with these sets, though air-cooled compressors can be fitted, but the latter mean the complication of a further radiator because the radiator fitted to the "Fordson" is not of sufficient capacity to cool both engine and compressor when working on load. On the other hand, the unjacketed type is, we are assured, giving every satisfaction, and since the compressor works quite close to the job, the efficiency of the compressor, and of the pneumatic tools, is very little affected by the fact that the temperature is somewhat higher than would occur with a water-jacketed machine. Among the advantages claimed for this form of plant are that it can be driven under its own power to the site of operation and immediately put to work, and that it is as cheap, or cheaper, than an ordinary portable set of the same capacity, which has to be towed to its job. The tractor has a towing bracket at the rear, and can be used in the ordinary way for towing a trailer.

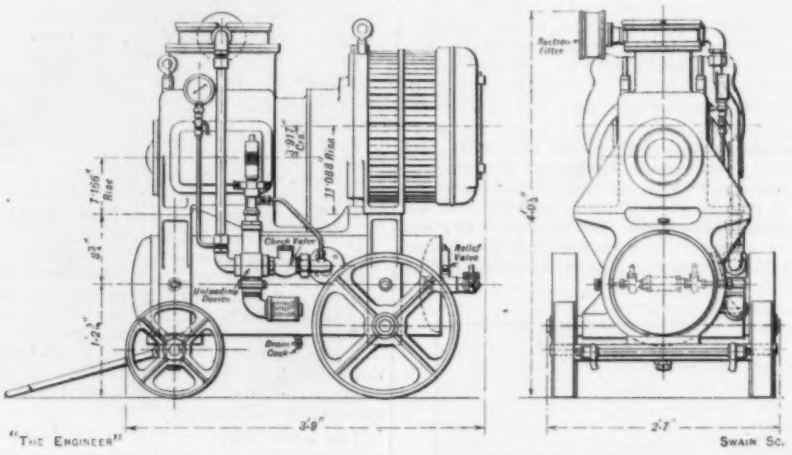


FIG. 19—PORTABLE AIR COMPRESSOR FOR TRAMWAY REPAIRS—REAVELL

the heaviest conditions. The cylinders of the compressor are 6in. in diameter by 4in. stroke, and the working pressure is 80 lb. per square inch at 575 revolutions per minute. The motor is of the "Emcol" totally-enclosed type, and is designed to develop 13 horse-power. It is series wound, and furnished with a special air-cooling arrangement to enable it to run at full load for lengthened periods. The gears between it and the compressor are totally enclosed and run in oil. The compressor has an unloading device, and, as soon as the pressure in the receiver rises to a predetermined value, the plant runs light until there is a further demand for air, when it at once starts compressing again.

Current for operating the motor is obtained from the overhead trolley wires in such a way that the tramway service is not intertered with. An upright bamboo pole is secured to the plant, and has hinged to its top a further pole, the longer end of which is furnished with a copper plate bent round so that it can pass under and embrace the trolley wire. The

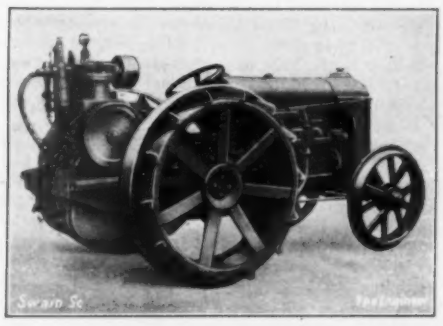


FIG. 20—REAVELL COMPRESSOR ON FORDSON TRACTOR

shorter end of the hinged pole is connected to the base of the upright pole by means of a hook and chain with a strong spring inserted in its length, the spring having the effect of bringing the bent copper plate into good metallic connection with the trolley wire. A cable is led down from the plate to the motor switch. The weight of the complete plant is only 15 cwt., so that the unit can be easily moved about or hoisted on to a lorry for conveyance to the place where it has to work.

Another interesting exhibit on the Reavell stand was one of the firm's compressor sets mounted on a "Fordson" tractor. It is illustrated in Fig. 20. The tractor is a standard article and can be supplied either with steel wheels, as shown in the illustration, for use at home or abroad in roadless districts, or mounted on rubber-tired wheels. Two sizes of compressor can be fitted to this size of tractor, but only one was exhibited. Both types of compressor are unjacketed machines of two-cylinder vertical single-acting construction. The drive is taken from the pulley provided on the tractor to a belt fly-wheel on

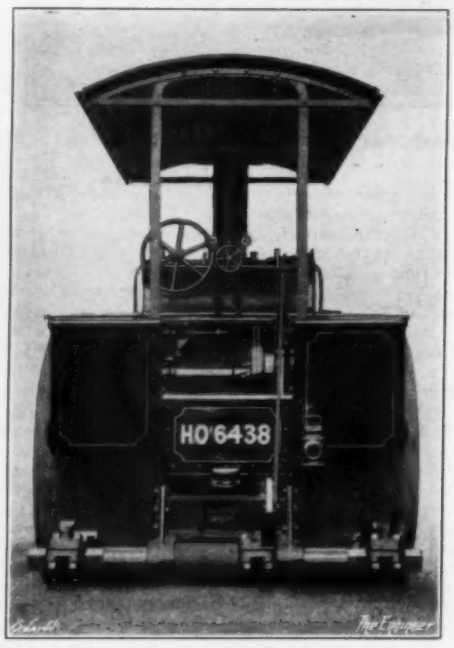


FIG. 21—SCARIFIER ATTACHMENT—WALLIS AND STEEVENS

a 10-ton. Our readers are familiar with the design of these rollers, so that no description is called for in the present instance, but in the case of the heavier roller there was a distinct novelty in the fact that it was fitted with a novel arrangement for scarifying. It is illustrated in Fig. 21, and by means of it, it is possible to scarify over the full width of a roadway without altering the direction of the roller. The idea is quite simple. As will be observed, it consists of a stout bar of forged steel, which is carried and can be rotated in two bearings in a forked casting that is rigidly attached to the rear of the frame of the roller, centrally between the two hind wheels. The ends of the bar are squared for the reception of the scarifier tine holders, one at each end of the bar, and it will be observed that the length of the squared portions is sufficient to permit of adjustment in the horizontal positions of the tine holders. A feature of the arrangement is that the scarifier can be put into and out of operation by means of a toggle joint arrangement, which is worked by a lever, either from the driver's platform or from the ground, and which has the effect of rotating the bar through an angle sufficient to lift the tines well clear of the road when it is desired to keep them above the surface. The toggle joint arrangement prevents the tines from being forced up when they are at work. Several claims are made for this arrangement, among which is that it is extremely rigid and that the entry of the tines into the ground is automatic, no screws or gears being required to effect it.

Sir W. G. Armstrong, Whitworth and Co., Ltd., of Openshaw Works, Manchester, had a very varied show, including two steam road rollers, a 4 to 5-ton per hour drying and mixing plant for tar-macadam and asphalt, a bitumen boiler, a combined spraying and gritting machine, a portable air compressor, and a large number of tools suitable for road breaking, &c. All of them, however, have been previously described, and are well known. There was, however, one small tool which is new, and which is as ingenious as it is simple and handy. It was a pair of pliers for making air-tight connections on hose couplings, and it is quite worthy of a few words of description. It is illustrated in Fig. 22, and its action will be readily understood. Imagine a piece of iron wire, No. 16 gauge or so, some 15in. long, and bent more or less into the form of a hairpin, but with two right angles instead of the usual curve. Then imagine the ends of the wires bent round the hose and threaded through the loop of the "hairpin" so as to make a double hoop round the connection which it is desired to make tight. The small slot seen in the bottom jaw of the pliers is then made to engage with the small length of wire coming between the two right angles of the loop, and one of the loose ends of the wire is laid in the slot in the pivot pin of the pliers, while the other loose end is laid in a corresponding slot at the other

FIG. 22—PLIERS FOR MAKING HOSE JOINTS

end of the pivot. The two handles of the pliers are then pressed together, and allowed to spring apart again several times, with the result that by means of a clever spring-operated double ratchet and pawl arrangement inside the hinge box, the pivot pin is made to revolve by steps, each step representing a pressing and releasing of the handles. The ends of the wire are in this way made to coil themselves round the pin, and since there is purchase by reason of the slot in the lower jaw engaging with the loop in the wire, the two hoops of wire are made to press tightly round the hose, so that a satisfactory air-tight joint is formed. When it is judged that sufficient tension on the wires has been brought about, the pliers are revolved through a small angle with the loop in the jaw slot as a centre, so that the ends of the wire are bent and made to embrace the loop sufficiently tightly to prevent slipping. The pliers are then disengaged, any unnecessary length of wire cut off by the cutters formed in the pliers, and the ends hammered down. We have not space to describe the mechanism inside the hinge box, but can only say that it is well designed and beautifully made. It only takes a few seconds to make a joint.

In addition to examples of different applications of "Universal" and "Simplex" steel sheet piling, the British Steel Piling Company, Ltd., of 54A, Parliament-street, London, S.W. 1, showed several concrete mixers, and a model of a pile-driving plant complete with a McKiernan-Terry piling hammer, operated by compressed air.

A novelty applied to one of the concrete mixers was a mechanism for vibrating the feed hopper as it is discharging the mixture of aggregate and cement into the mixing barrel. With this device there is no difficulty whatever in ensuring that the whole of the contents of the hopper is transferred to the barrel, and no shovelling or scraping is necessary.

With the model pile driver a demonstration was given of the operation of casting "Zenith" Vibro concrete piles *in situ*. The plant, of which the model exhibited was a replica on a small scale, consists of a pile-driving frame and a 16in. diameter hollow tube, provided with an enlarged ramming end, 17in. in diameter. This tube, which is furnished with an iron shoe, 17½in. in diameter, at its entering end,

is placed upon the spot the pile is to occupy, and is driven by a 2-ton hammer—which is convertible into an extractor—to the required depth—see the left-hand view in Fig 23. The cavity formed in the ground is of the same diameter as the shoe, namely 17½in. When the tube is withdrawn, the shoe, being loose, is left at the bottom of the hole and forms the foot of the concrete pile. Before extracting the steel tube by steam hammer action, the tube itselt is completely filled with a fairly stiff mixture of concrete. The operation of forming the pile is illustrated in the right-hand view in Fig. 23. The tube is withdrawn by means of the hammer cylinder and links attached to its head. As it is hauled out, an up and down vibratory motion at the rate of some eighty strokes per minute is imparted to it, with the result that the concrete cannot remain in the tube, but is forced out of it and is tamped downwards and outwards by the hammering action of the enlarged end of the tube. In this way the concrete is forced hard against the face of the cavity, and the pile is soil-supported throughout its length. There is no waste of material, for only sufficient to bring the pile head to the exact level required need be put into the tube. If it be desired to employ reinforcement the necessary rods are placed in the tube, after the latter has been driven and before the concrete is poured into it.

A large number of claims are made for this system of constructing concrete piles. Some of them are as follows:—(*a*) It is economical, and with it foundations can be formed at a cost quite 50 per cent. below that incurred for foundations constructed with pre-cast piles; (*b*) it is rapid, for with it a 40ft.

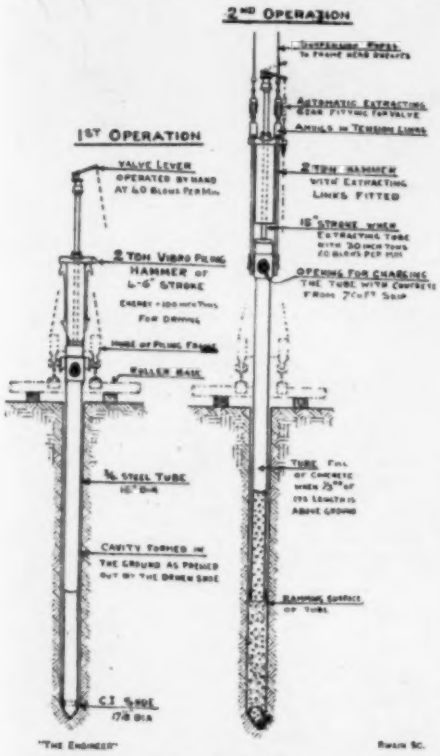


FIG. 23—DIAGRAM SHOWING FORMATION OF "VIBRO" PILES

pile can be completed in one hour; (*c*) voids are impossible, every pile being a perfect column of compressed, solid concrete; (*d*) piles from 10ft. to 75ft. in length can be formed, and, owing to the method of casting them, they fit the holes they occupy perfectly; (*e*) the bearing capacity of "Vibro" piles is 50 per cent. greater than that of any other tube-formed pile; (*f*) from eight to fifteen piles a day can be completely installed; (*g*) it is the only system in which a medium or dry "mix" can be employed. These claims are, of course, those made by the company. We have not ourselves had an opportunity of substantiating them. The system, however, appears to us to be perfectly sound in principle, and as evidence that it actually is so, we may say that it was adopted for the Lea Valley Viaduct, which spans the Lea Marshes. On this work reinforced piles were used and some nineteen or twenty of them were completed in one day, or considerably faster than the rate claimed above. Another recently completed work for which they were employed was the formation of the foundation for a new 500,000 cubic feet three-lift gas holder for the Troon Corporation. For this work 152 piles of lengths varying from 20ft. to 30ft. were used.

John Fowler and Co. (Leeds), Ltd., had an excellent exhibit comprising among other things a 10-ton steam roller, a compound road spraying, re-surfacing and gritting plant, and a 6–7-ton steam three-way tipping wagon. All were of this firm's excellent standard patterns, but they displayed no particular novelties. There was, however, a model of a novelty in the form of a machine designed accurately to stretch drawn steel wire or rods of any section for concrete reinforcement. This machine, which has been patented by Mr. John W. Liversedge, of Reinforcements, Ltd., of Westminster Chambers, 28, East-parade, Leeds, is being made by Messrs. Fowlers. It has recently been employed for placing the reinforcement in roadways for the Leeds Corporation, and it is illustrated in Figs. 24 and 25, the first of which shows it at work at Leeds and from which its construction and operation will be readily understood. With it, plain drawn steel wire or mild steel rods of any section can be used for road reinforcement, and stretched tightly at the required height, so that concrete can be laid above and below it without disturbing the position of the wires. The apparatus consists of two com-

FIG. 24—THE LIVERSEDGE REINFORCEMENT-PLACING MACHINE IN OPERATION—JOHN FOWLER AND CO.

pound girders, which grip the wires or rods at both ends, the pressure being applied by set screws. One girder is fastened by holdfasts in the ground, while the other is pulled by a special machine to give the necessary tension in the wires. We gather that an initial stress of about 400 lb. per square inch is put on. With a single machine a width of 20ft. can, so we understand, be reinforced in this way at one setting, the length done at one time being dependent on the conditions of concreting and convenience of work. After the first setting only one girder is employed—that connected to the tensioning machine—since

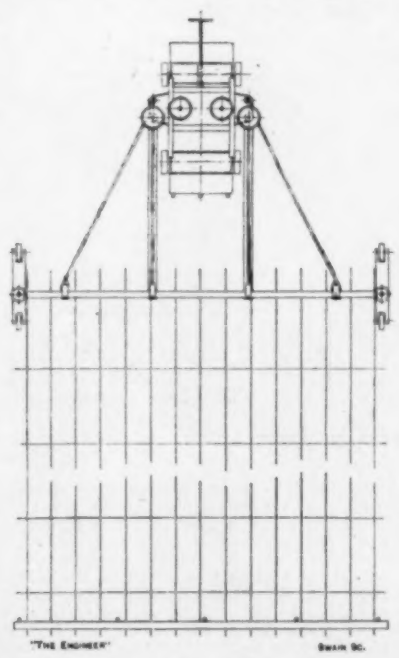


FIG. 25—DIAGRAM OF REINFORCEMENT-PLACING MACHINE

the wires are firmly held in the previously laid concrete, and the next lot of wires can be attached to their ends, so that a continuous bed of reinforcement fabric is formed. When the full width of a rod is to be concreted at one time, two or more tensioning machines can be used, side by side in the road itself or one machine can be fixed at each side of the road, with a special girder spanning the whole width between them.

The use of the machine is not confined to the placing of reinforcement for road making, for steel rods or any sectional material for bridges, floors or other reinforced concrete structures can be held in position and stretched taut just as are wires. Lateral and longitudinal spacing can be varied to meet different conditions, and both single and double reinforcement can be laid by the machine. In the latter case the tension holds the two layers of wire at the right distance from each other without the need of any diagonal wires or spacers.

In addition to the tensioning machine and the girders, a special movable carrier for the rolls of unused wire can be provided. This carrier keeps the wire clean and allows the longitudinal reinforcement to be made without breaking off the wires between sections. Two or more roller drums are mounted on the machine, according to the number of wires in use, and ratchet gear is fitted on each for giving a preliminary tension to the wire while fixing it in the girder.

The following wide claims are made for this machine—(*a*) Ordinary steel wire or rods bought in the open market can be employed, and there is no need to use proprietary fabrics; (*b*) the reinforcement is easy to handle, and can be laid throughout by unskilled labour under a foreman's supervision; (*c*) for double reinforcement no diagonal members or spacers are required to hold the material in position; (*d*) every ounce of steel does useful work in carrying the loading stresses; (*e*) the machine enables fabric to be woven to meet requirements; (*f*) the reinforcement is accurately laid and stretched at the right depth to give the greatest efficiency; (*g*) the wiring can be spaced exactly to suit the conditions of loading and any specification; (*h*) no overlapping in the reinforcement is necessary, each length is jointed to the previous one and then stretched, so that an uninterrupted layer of material is obtained; and (*j*) curves can be laid without waste of material or overlapping.

A wide range of pumps was shown by the Pulsometer Engineering Company, Ltd., of Reading, including a 5in. "Stereophagus" pump, a 6in. "Flexala" rubber-lined pump for dealing with sewage and other liquids containing grit, and a neat little portable pumping set consisting of a centrifugal pump coupled to a "Hamworthy" engine. All the machines, however, were of the company's standard types, and did not appear to embody anything specially novel. The same may be said of Tangyes Ltd., of Birmingham, who had an effective exhibit of steam, petrol and heavy oil engines, and numerous pumps of different types, pulley blocks and lifting jacks. In fact, it was a typical Tangye exhibit; but all the machines, &c., appeared to be of this firm's well-known designs and construction, which are too well known to call for special description at the present time.

On the stand of Aveling and Porter, Ltd., of Rochester, there were examples of the firm's steam road rollers, one of some 12 tons weight, and another of about 10 tons empty. We noticed, however, that both had boilers of the Belpaire type and that they were fitted with piston valves instead of the usual flat valves. Both rollers had scarifiers of the Price patented resilient type, the heavier roller having three tines and the lighter two tines. The scarifier is arranged on the right-hand side of the tender, while on the left-hand side of the larger roller there is a Brown and Snodin patented roadside excavator, which is an appliance specially designed for cutting away roadside waste and for excavating below roadside level for foundation work. In arrangement it is not unlike a plough, for it has a coulter knife and a

curved share to remove the material cut away. It is stated that at one operation it will cut away roadside waste 18in. wide and up to 2ft. high, at the rate of 30 lineal yards per minute. It can, as just mentioned, be adjusted to excavate below road level, and when the roadside waste is not more than 18in. above road level, the two operations of removing it and excavating can be carried out simultaneously. By the use of this appliance the usual pick labour is eliminated, and there is practically no interference with the ordinary work of the roller, since, so the makers state, sufficient cutting and excavating can be done in less than half an hour to keep a gang of men employed for a full day in removing the material. We understand that three of these appliances have now been in use for over a year, so that a considerable amount of experience has been gained with them, and that as a result of that experience it has been proved that the amount of work which can be accomplished by one appliance is such that the cost of the excavation is reduced by two-thirds as compared with doing it entirely by hand labour. The appliance can be fitted to any type of roller or tractor, and takes only a few minutes to connect or disconnect. It overhangs the driving wheel of the roller on the near side, and clear of traffic, and can readily be placed for hauling behind the roller when travelling from point to point. It can also be transferred from one roller to another.

Roadways Equipment, Ltd. (late the St. James' Engineering Company, Ltd.), of 95, 97 and 99, St. James'-road, Glasgow, exhibited a portable asphalt macadam plant which comprises two separate units, both of them on wheels, one unit being the dryer and the other embodying the mixing arrangements, &c. It is termed by its makers their improved M M type, and it is illustrated in Fig. 26. A bucket type elevator lifts the cold material—sand and stone—into a front chute on the dryer, by means of which it is delivered into an inner drum, fitted with skew and longitudinal feed angles, that revolves inside a steel casing containing two furnaces—main and auxiliary. The discharge end of the inner drum has a perforated screen extension through which the dried sand is delivered into one compartment, whilst the stone tails over the end of the screen into the other compartment of a twin discharge hopper. Both compartments are fitted with discharge doors to allow the heated fine or coarse material to be discharged into the batch bucket—which is fitted with an adjustable gauge to suit different mixing requirements. The contents of the batch bucket are lifted into a robust mixer, fixed on an overhead working platform. The mixer is furnished with manganese steel blades, which are fitted to two parallel shafts and are so set as to sweep the material from either end of the mixer towards a central sliding bottom door through which a discharge is made into a waiting lorry immediately underneath.

The passage of bitumen from the heating tanks to the measuring bucket, over the mixer, is effected by air pressure, a compact belt-driven double-cylinder enclosed compressor being installed below the mixer platform for this, and tank agitating, purposes.

A main and countershaft, running in ring-oiling bearings, carry the necessary belt pulleys, sprocket wheels and clutches, &c., by which the plant as a whole, or any individual part, may be revolved or stopped as required. The working platform around the mixer is commodious and the controlling levers are well arranged for the workers' convenience.

The dryer and mixer units are mounted on heavy wheels and axles, and, in conjunction with the brake gear, all details seem adequate for undertaking long road journeys. The dryer shown was fitted with fire-clay lined flues and had an oil fuel system installed for both the main and auxiliary furnace. We understand, however, that a change over to coal firing can, if necessary, be quickly effected, since the furnaces are equally well adapted for either system.

The plant is designed for a daily output of from 30 to 35 tons of topping and from 60 to 65 tons of binder, with 5 per cent. of moisture in the cold aggregate. Sixty tons a day may, the makers assure us, be regarded as a conservative output from one of these plants on asphalt macadam calling for a dryer discharge temperature of about 400 deg. Fah. In the illustration the plant is shown driven by a portable steam engine, but at the Exhibition a motor was fitted for the purpose.

This company also exhibited a useful-looking "road toaster" or "burner-off" for use in repairing and patching asphalt macadam road surfaces. It consists of a metal hood carried on wheels and furnished with an oil burner which can be directed on to any point of the road beneath the hood. It is illustrated in Fig. 27, which shows it so well that further description is unnecessary.

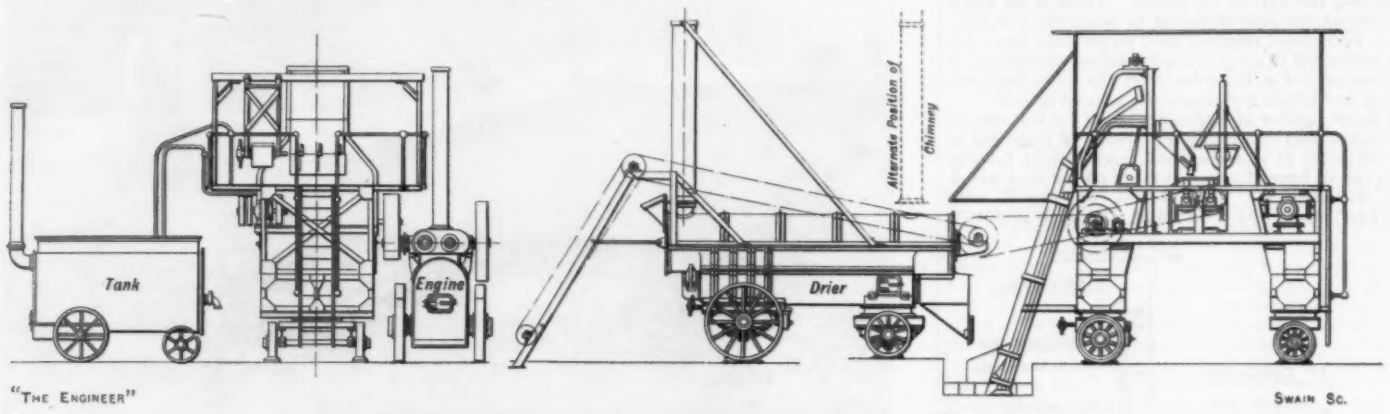


FIG. 26—PORTABLE TWO-UNIT ASPHALT MACADAM PLANT—ROADWAYS EQUIPMENT LTD.

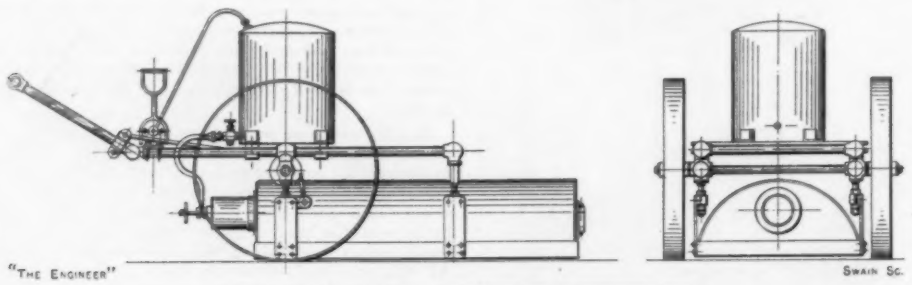


FIG. 27—"ROAD TOASTER"—ROADWAYS EQUIPMENT LTD.

South African Engineering Notes.

S.A. Gold Mines in 1924.

The outstanding features in the annual report of the Union Government Mining Engineer are the following:—The tonnage treated by the Witwatersrand Gold Mines was 28,527,010 tons, compared with 26,765,126 tons in 1923. The labour force employed was 18,403 whites and 179,330 coloured persons, as compared with 17,357 whites and 176,180 coloured in 1923. Thus tonnage treated per white person employed was 1550 tons per annum and per coloured person 159 tons per annum, as compared with 1542 tons and 152 tons respectively in 1923. Total value of gold recovered on the Witwatersrand, inclusive of premium, was £43,495,614—an increase of £3,049,375 over 1923. Working costs were 19s. 7d. per ton, as compared with 20s. in 1923, and gross profits 10s. 11d. per ton, as against 10s. 3d. The gross profit of £15,570,993 was not all available for dividends to shareholders; a large portion of it was absorbed by such items as interest and redemption of loans and debentures, the Government's share of profit, Union and Provincial taxation, oversea taxation, capital expenditure, realisation charges, directors and auditor's fees, depreciation, donations, &c. The net profit for 1924 is put at £11,806,253, and the total cost £31,689,361. Union and Provincial taxation in the shape of income tax and employers' tax amounted to approximately £2,000,000, or 1s. 5d. per ton; while the Government's share of the profits last year was £1,456,603. Dividends declared by the Witwatersrand producing mines—£9,557,657—show an increase of £1,097,834, as compared with 1923. The expenditure on salaries and wages was £13,256,864, and on stores £13,250,185. The £7,092,582, salaries and wages disbursed to white employes, includes an amount of £318,043 as leave pay, £32,072 as bonus, and £167,652 as special premium bonus. The average price of gold was 2s. 6d. per ounce higher than in the previous year. Looking back some years a striking comparison is furnished by taking the basis per 1000 tons hoisted by the Witwatersrand producing mines per working day, and the average number of persons at work. Whereas in 1904 there were at work 310 whites and 2240 coloured employes per 1000 tons, hoisted per day, last year that figure was brought down to 159 whites and 1621 coloured. During 1924 machinery and stores, of the value of £16,096,982, were consumed by the mining industry, not including alluvial diamond diggings, an increase of £402,262 on 1923. Of this amount the gold mining industry accounts for £13,778,679, or 85.6 per cent. of the total. An amount of £9,869,075 was expended on South African products, including articles whereof the chief cost of production was incurred in South Africa. For the eight months of 1925, up to the end of August, the total gold production of the Transvaal has been £26,867,640, a decrease of nearly £2,000,000 as compared with the corresponding period of 1924. The decrease is, of course, due to the fact that there is no gold premium, South Africa having returned to the gold standard, and sterling being practically on a par with the dollar.

Mineral Output of the Union.

The value of the mineral output of the Union of South Africa for the first eight months of 1925 was £36,052,671, as compared with £38,612,997. The totals are made up as follows:—

	1925. £	1924. £
Gold	27,218,792	29,846,892
Silver	116,438	136,912
Osmiridium	91,885	50,860
Diamonds	5,303,690	5,347,991
Coal	2,593,655	2,520,296
Copper ore	355,022	330,953
Metallic tin, &c.	186,277	182,031
Other minerals	186,912	197,062
Totals	£36,052,671	£38,612,997

The decrease in the value of gold is due to the disappearance of the premium on gold consequent upon sterling recovering to parity. The actual quantity produced in the first eight months of this year was 6,407,803 fine ounces, as compared with 6,327,825 fine ounces in the same period of 1924.

New Steel Lighters.

Particulars of the four steel lighters being built at Uitenhage Railway Workshops are now available. They are as follows:—

Length overall	85ft.
Length between perpendiculars	81ft.
Width 'midship (moulded width)	20ft. 6in.
Depth ot hold	8ft. 6in.
Depth of flooring	1ft. 1in.
Hatch	25ft. by 15ft.
Height of hatch	16ft.
Deadweight, approximately	100 tons
Cargo capacity	180 tons

Mr. A. G. Watson, the mechanical engineer at Uitenhage works, prepared the drawings and supervised the setting out. A bar furnace was built to handle the bars for the frames, reverse bars, stringers and keelsons, slab blocks were prepared for the bending of the frames, reverse bars, &c., also a quantity of dogs and blocks necessary for work of this kind. It was decided to build and erect only one boat at Uitenhage, the remaining three to be built from matter templated from the model boat, and thus to save the cost of erecting at Uitenhage, and also the cost of dismantling prior to dispatch to Port Elizabeth for final erection and completion. The boats were built under the Holly Hatten template process—a process which has proved very satisfactory in the shipbuilding yards in America. On the receipt of the material from oversea, the work of the actual building of the boats was put in hand on August 11th, 1924, and completed at Uitenhage on August 15th, 1925. The erection of the boats at Port Elizabeth was put in hand in December, 1924, and the first boat was launched on June 18th last; and the second on August 17th. The third and fourth were launched some six weeks later, five months before contract time. As 1152 plates and 1154 angles had to be marked off, punched, sheared, bevelled and bent, countersunk, and approximately 125,000 rivets driven home, it will be realised that it was a great achievement for a depôt like Uitenhage, and also for the slipway staff at Port Elizabeth. It has proved to the Administration that this sort of work can be done in South Africa, and at a less cost than the boats imported from oversea. The wagon shop is now building one boat for Mossel Bay.

Railway Matters.

A STEAM-OPERATED dumper for 120-ton cars for loading vessels was recently installed for the Pennsylvania Railroad at Sandusky, Ohio. Over forty cars per hour can be handled, giving a tipping rate of about 4800 tons per hour.

THE ferry across the Humber runs between New Holland on the Lincolnshire side and Hull on the Yorkshire. The pier at the former station belongs to the Great Central section of the London and North-Eastern Railway, and that at Hull is the property of the Corporation of that place. The New Holland pier is now to be reconstructed, and a contract for the work has been let to Sir William Arrol and Co.

ON page 11 of our issue of July 3rd last we mentioned that the Great Western Railway desired to join the Vale of Rheidol Railway, from the Devil's Bridge, at Aberystwyth, with the main line in that town. Such an arrangement would not only be an economy and a public convenience, but the time for making the change is opportune, as the main line station is under reconstruction. An Order under the Railways Act has now been made by the Minister of Transport.

THE Whitemoor locomotive depôt at March on the former Great Northern and Great Eastern Joint Line—now London and North-Eastern—is mainly used by engines working mineral trains between Doncaster and London, *viâ* Spalding. It is now proposed to carry out considerable improvements there by installing a mechanical coaling plant to be operated electrically, constructing a triangle for engine turning purposes, providing additional water facilities, and carrying out other alterations which are calculated to have a very beneficial effect on the working. The whole scheme will cost £43,000.

WHEN the Kennington extension of the Hampstead line of the London Electric Railway Company is opened, the Charing Cross Station on that line will have to be reconstructed. In view of the increased traffic to be expected then, a circulating area is to be provided under the Metropolitan District Station. Escalators will connect the new area with (1) the Hampstead line, (2) the District station, and (3) the street. With the last-named, provision there will be no need for Hampstead line passengers from or to the streets to pass, as now, through the District station. The three stations at Charing Cross cater to-day for 35 million passengers a year; the new station will be able to deal with 50 millions.

A TERRIBLE disaster occurred on Monday evening last at Fenny Stratford, on the Bletchley-Bedford section of the London, Midland and Scottish Railway. There is a level crossing at that point and, as the signals were lowered for a train to pass, the roadway was closed by the gates. For some reason, not clear at the time of writing, the driver of a road motor vehicle failed to stop clear and allowed the char-à-banc he was driving to run through the gates and to foul the railway. It was struck by the train and six passengers in it were killed. As the engine of the train was derailed, the disaster will form the subject of an inquiry by one of the railway inspecting officers of the Ministry of Transport.

THE death was recently announced of Mr. J. P. Annett, who was connected with the signalling of the London and South-Western Railway for thirty-seven years, and was that company's signal superintendent when he retired in 1907. Several useful signalling appliances were introduced by him. One peculiar to the London and South-Western is a shade below the signal spectacle which prevents a driver, standing close to a signal in the "on" position, from seeing the white light of the lamp through the lower—the green—spectacle. He also designed a joint for point rodding and revived the route indicator, whereby one arm, with a numeral or letter, can provide for the entrance into any one of two or more roads. Contrary to the general belief, Mr. Annett did not invent the well-known Annett's key. That was patented by his father, J. E. Annett, of the London, Brighton and South Coast Railway.

COMPLAINTS in the daily Press on what are comparatively quite trivial matters are so common that the appearance in *The Times* on two days last week of letters in praise of railway companies deserve some mention. The introduction of the new service for Watford on the Metropolitan led to a complaint from users of the three stations in the tunnel section between Baker-street and Finchley-road. That complaint prompted a testimonial from the secretary of the Northwood Golf Club, which said of the Metropolitan Railway that "there is certainly no other railway company that compares with it in its efficient handling of traffic or its success in avoiding real delay during foggy weather." Two days later appeared a letter in praise of the punctuality of the trains arriving at St. Pancras, and saying, "My reason for bringing these facts to public notice is because I feel that this, the Midland, section of the L.M.S. seldom receives the commendation it deserves."

THOSE readers of THE ENGINEER who have taken an interest in the question of automatic train control in the United States will remember how the railways there opposed its introduction. How successful they were in their opposition may be judged from the fact that although the matter is now twenty years old and has been a legal requirement for over four years there were, until twelve months ago, only four installations fixed. The Inter-State Commerce Commission then issued a compulsory order for forty-five railways, each to equip one passenger division on its line. That work is approaching completion, and it is amusing now to find the railway companies taking credit to themselves in the following words of the chairman of the Automatic Train Control Committee:—"Not only are the railroads spending millions of dollars in an effort to carry into effect the orders of the Inter-State Commerce Commission regarding train control, but they are also lending their best efforts to develop train control devices by actual operation under all sorts of conditions. They are also doing everything they can to determine to what extent train control devices will add safety in the actual operation of trains and the effect on traffic movements. They also are doing everything possible to assist the Inter-State Commerce Commission in arriving at conclusions as to the efficacy of various devices."

Notes and Memoranda.

A LABORATORY of hydraulics is to be added to the Bihar College of Engineering, India, at a cost of Rs. 50,000.

SOME experiments are being carried out in the Gwendraeth Valley, near Llanelly, with a view to preventing, if possible, gas blower explosions in mines.

WHEN the Sugarloaf Dam in the valley of the Goulburn, Victoria, is completed storage for 960,000 acre-feet of irrigating water will be provided. It has now been decided to utilise the water for power purposes also.

WHEN all the potential energy of the Nipigon River, Ontario, is developed it will, according to Mr. O. Holden, produce 200,000 horse-power. The head available is 244ft. The existing plant on the river develops only 45,000 horse-power.

THE Lahore Municipal Committee has approved of the preliminary estimate, prepared by the Sanitary Engineer to the Punjab Government, amounting to Rs. 28,72,000, regarding the new water supply extension scheme, and has entrusted the working of the scheme to the Public Works Department.

A STEAM power plant of 100,000 horse-power is to be built by the Southern Power Company, of Carolina, as an insurance against loss of power through drought from the hydro-electric stations. Steam is to be used at a pressure of 350 lb. per square inch and 700 deg. The company's water plants have a total capacity of 600,000 kilovolt-ampères.

IN 1924 the eleven automobile factories in Canada produced 98,245 passenger cars, 18,043 trucks and 16,172 chassis, a total of 132,460 cars with an aggregate selling value of 88,240,418 dollars. This was a decrease of 10 per cent. from the 1923 production of 147,202 cars valued at 96,614,176 dollars, according to a statement issued by the Dominion Bureau of Statistics. Raw materials costing 64 millions were used.

WIRELESS engineers at Geneva are discovering that the path of true broadcasting never runs smooth. During the transmitting tests with the new Geneva broadcasting station, which began operations on 1000 m., it was discovered that serious clashing took place with the Hilversum transmissions on 1050 m., and also with a harmonic of the Munchenbuchsee Station. Geneva is at present experimenting on wave lengths in the region of 800 m.

A STUDY of the properties of typical crude oils from the producing fields of the western hemisphere has been made by the American Bureau of Mines, and a report on the subject, just issued, includes comments, tabulated data, and individual analyses of crude petroleums typical of the producing districts of Canada, Mexico, Trinidad, Venezuela, Argentina, Colombia, and Peru. For purposes of comparison the report also contains analyses of typical crude oils from the largest producing districts of the United States.

SOREL'S magnesium oxychloride, more generally and somewhat erroneously known as magnesia or magnesite cement is, according to *Bulletin No.* 1 of the Building Research Section of the Department of Industrial Research, the strongest cement used in any quantity for building purposes at the present time. On the Continent and in America the cement has, since its invention, formed the basis for stucco artificial stone and bricks, but it has not found favour in this country in those capacities in the past, nor does it seem likely to in the future.

IN the course of a paper on "Highway Operations," read before the Boston Society of Civil Engineers, Mr. G. H. Delano said that it is frequently found that a road that has once been cleared through a drift of snow, particularly when a vertical cut is left, quickly fills in again. Where the snowfall has any degree of permanency it has been found that if furrows are formed in the snow on the proper side of the road and about 150ft. away a snow fence is formed that will prevent drifting. It is, of course, in such cases necessary to renew the furrows from time to time.

IT would appear from some remarks recently made in Washington by Mr. A. W. S. Herrington, of the Motor Transportation Division of the Quartermasters Corps, U.S.A., that the Americans are discovering the limitations of tramways. He said "Inevitably the motor vehicle must take its proper place as a passenger-carrying unit in urban transportation, and eventually it must replace street car lines on congested city streets. In isolated cases the change already has been made, and within the next five years it will have reached proportions that few can now conceive." Mr. Herrington advocated the use of double-decked motor omnibuses.

THE official report on the explosion of a copper winch steam pipe on a twenty-eight-years-old steamer emphasises the necessity for great care in repairing such pipes by brazing. The pipe was about 4in. in diameter by 0·12in. thick and had been repaired by means of a brazed on patch 5in. by 3in. It failed by explosion just below the patch, but fortunately no one was hurt. Commenting on the fact, the Engineer Surveyor-in-Chief says:—"The pipe was of considerable age, and had developed defects at some previous time which had been inexpertly repaired, the material during the process of repair having been overheated. Evidently the part in question had been on the point of failure for some considerable time, and the movement of the pipe due to heat expansion after steam was admitted into it finally caused rupture."

SOME very curious researches have been recently described in *La Revue Hydrographique* with regard to sound waves. These waves, as is well known, are longitudinal, whereas light waves are transverse vibrations. They cease to be audible at frequencies somewhere between 10,000 and 20,000 cycles per second. In France experiments have been proceeding on the effects of waves of inaudible frequencies between 40,000 and 100,000 originated by means of a three-electrode oscillating vacuum tube. The emitted power may be considerable. With a transmission of about 1 kilowatt through water, fishes in the path of the beam were killed. Apparently there is no difficulty in confining such a beam under water, and there is little loss by dispersion. By noting the time elapsing between the emission of an impulse and the echo the distance of the reflecting object can be calculated.

Miscellanea.

THE Dover–Calais turbine mail steamers Biarritz and Maid of Orleans are to be converted into oil-burning vessels. The Biarritz has already gone to the Clyde, where the work is to be carried out.

A CONFERENCE of those interested in mining in the Dominion of New Zealand will be held in New Zealand during the currency of the New Zealand and South Seas Exhibition. The conference will open on February 3rd.

THE Newcastle and Gateshead Corporations are seeking power to provide lifts from their respective quaysides to the new high-level bridge, and to build warehouses and offices on the ground beneath the approaches to the bridge.

A DRAFT of further proposed amendments to the Indian Boiler Regulations, 1924, has been issued by and can be obtained from, the Department of Overseas Trade. Objections or suggestions must be submitted before January 10th.

PROPOSALS are being put forward for the foundation of a monotechnic in London, to be devoted to the training of chemical engineers and utilising for the purpose the buildings of Finsbury Technical College, which is about to be closed.

THE Sunderland Town Council is considering the construction of a new deep-water quay, at a cost of £200,000. It would be 600ft. long and be provided with two lines of rails, and a two-storey warehouse on a level with the High-street.

A SCHEME for the construction of a network of roads in Hunan, China, has been put forward by the local authorities. It is proposed to make six roads, with a total length of 1200 li, at a cost of about 3,000,000 dollars. One li is roughly a third of a mile.

IN view of water power developments expected at points near the Ontario border, the Quebec Government has altered its terms of lease contracts for the harnessing of such waterfalls, so as to prevent any of the horse-power being exported to the United States.

THE Barnsley Education Committee has invited the Miners' Welfare Committee, which has made a grant of £15,000 towards the cost of erection and equipment of a College of Mining in Barnsley, to give further financial assistance. The plans have had to be revised in order to reduce the cost.

THE Government of Finland has, according to the *Chemical Trades Journal*, proposed that production at the State sulphuric acid and superphosphate plant at Kotka should be increased and a new plant built at Wilmernstrand. A grant of 14,000,000 Finnish marks is to be made for this purpose. The present capacity of sulphuric acid manufacture at the State plant is estimated at about 10,000 tons a year.

WE are informed that the shallow-draught cargo and passenger steamer Fushun, which was built by John I. Thornycroft and Co., Ltd., at Southampton, for service on the Upper Yangtse River, of China, safely arrived at Hongkong on December 5th, after her long voyage of approximately 9500 miles under her own steam. We gave an illustrated description of this interesting vessel in our issue of September 11th, following her trials, which were carried out successfully on September 7th, previous to her leaving for the Far East.

DURING her independence, Estonia has developed new fields of activity, such as the shale oil industry, of which product she has enormous deposits, and in the use of which she is a foremost country. The peat and water power is utilised for electrification purposes, although the mighty Narva waterfall is still awaiting capital for development. She also has greatly improved her railways and harbours, especially the port of Tallinn (Reval), which is open all the year round, Pernau, and Narva. In the post-war period Tallinn (Reval) was one of the main routes for the world trade with Russia.

THE New South Wales State Cabinet has, according to the *Industrial Australian*, given definite approval to the State radio scheme as drawn up by Mr. Willis, Vice-president of the Executive Council. Mr. Willis has been asked to make further inquiries as to a suitable site for the broadcasting station in Sydney and for relay stations, the first of which will probably be established at Newcastle. It is estimated that to establish the central station and six relay stations in various parts of New South Wales will cost rather more than £10,000. At first, however, only one relay station will be established.

THE "white line" having now been generally adopted for the control of traffic at dangerous corners, inventors are busy with the problems it presents. A remarkable form is now under test at the junction of Golder's Green-road and the North Circular Road. In the centre of the latter an illuminated line over 30ft. long has been laid down by Haywards, Ltd., to the patent of Mr. R. F. Brown. The "line" is contained in a wrought iron trough sunk to the road level. In the trough are electric lamps, and the trough is closed with alternate sections of reinforced white marble and prism glass. Thus the line is visible by both day and night. The lighting up and extinguishing switch is controlled by a clock and the action is automatic.

THE great need of Apulia, says the monthly report of the Association of Italian Corporations, is to solve the question of securing water for the development of her agriculture and of the industries connected therewith. If these underground waters are to be utilised they must be raised to the surface by electric pumps. Such pumps, of small individual power, should be multiplied throughout the province, and power is also needed for running electric ploughs and other machinery so as to cultivate the land with a minimum amount of men and beasts, as the territory in question is at present unequipped with buildings and other requisites for housing and feeding a numerous population. Experts are now coming to the conclusion that rather than by taking water to the land by canals and aqueducts the real solution lies in installing electric lines and utilising the natural subterranean reservoirs. The artificial lakes now nearing completion on the Sila plateau will supply the energy for the many central stations now being erected throughout the region.

AUXILIARY MACHINERY OF THE MOTOR LINER GRIPSHOLM

(For description see page 634)

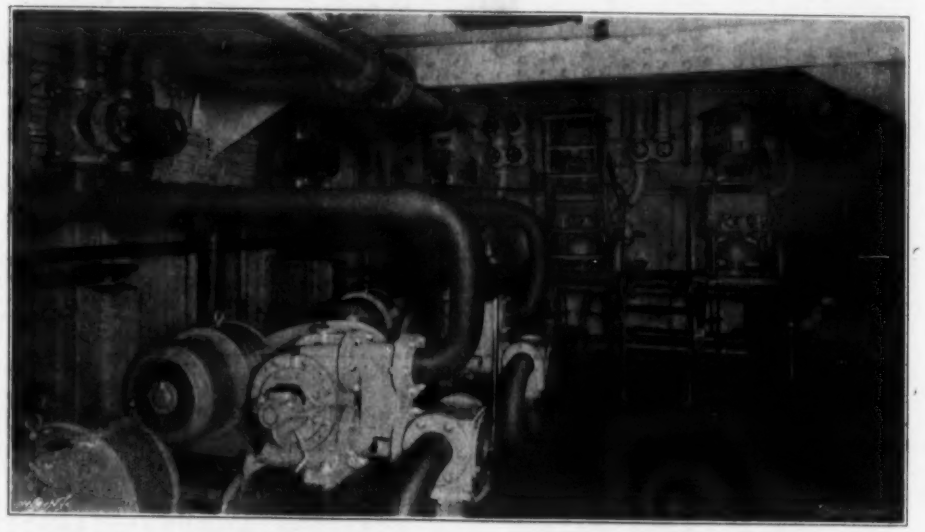


FIG. 8—FUEL OIL TRANSFER AND FRESH WATER PUMPS

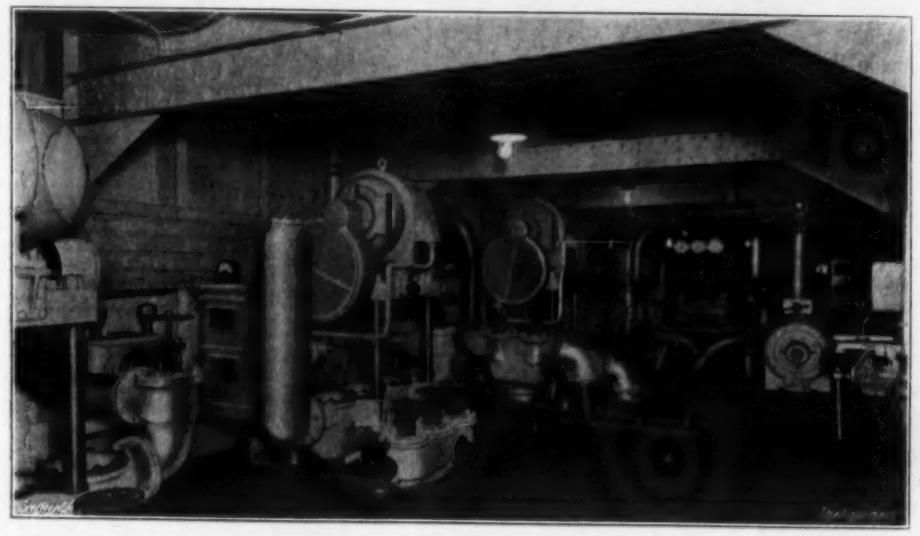


FIG. 9—BALLAST, BILGE AND GENERAL SERVICE PUMPS

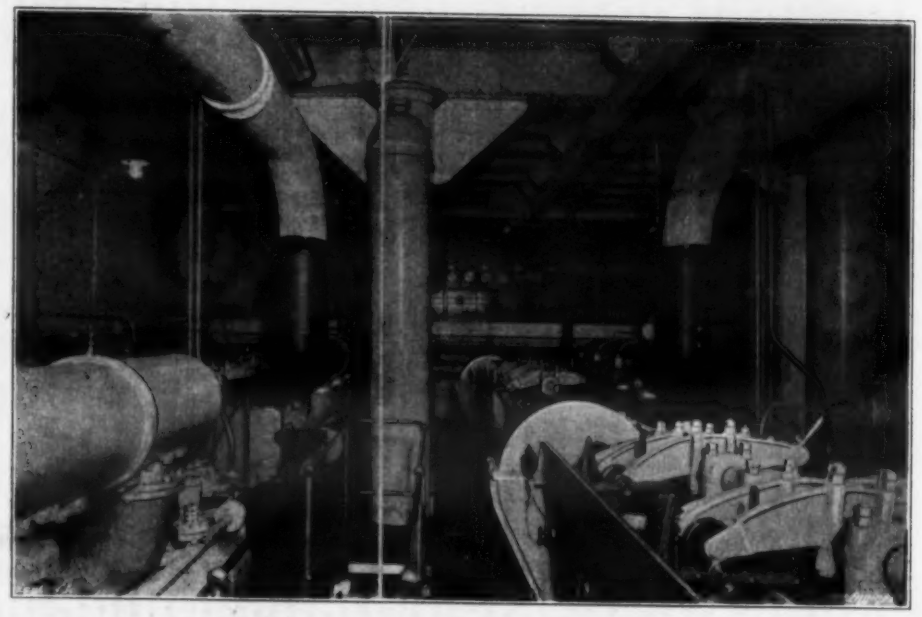


FIG. 10—VIEW IN AUXILIARY ENGINE-ROOM LOOKING AFT

FIG. 11—SWITCHBOARD GALLERY

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THE ENGINEER.

DECEMBER 11, 1925.

Naval Engineers.

THE Admiralty's proposal summarily to deprive naval engineer officers of the military rank which they have held for upwards of twenty years has caused amazement and indignation throughout the engineering community. Four of Britain's leading engineers—Lord Weir, Sir Charles Parsons, Sir Archibald Ross, and Sir John E. Thornycroft—have since elaborated in a letter to the Press the objections to this strange decision which were set forth in our leading article on November 27th. "It cannot fail," they observe, "to create not only profound disappointment and astonishment . . . but must also give rise to grave apprehension in the minds of those who have at heart the best interests of efficiency in our fighting services." Accordingly, they feel bound, on behalf of the profession they represent, to record "the most emphatic protest against a step which appears definitely to relegate the engineer officer of H.M. Navy to the inferior status he held in 1902."

There is no doubt that the signatories of this letter express the sentiment of all engineers, by whom the Admiralty's sudden decision is resented as a gratuitous affront to an honourable and honoured profession. Nor is it only on such ground that this cavalier treatment of an exceptionally able and devoted body of naval officers is open to grave criticism. It is not too much to say that both the safety and the fighting efficiency of a modern man-of-war depends in greater measure upon the engineer staff than upon any other specialist branch of the ship's company. Naval warfare has become "mechanisalised" to a degree which could scarcely have been foreseen when the Selborne scheme was introduced in 1902. Subsequent experience having demonstrated the impossibility of training all ranks of officers as skilled engineers, the engineer officer himself has become the king-pin of the whole naval organisation. Never before has he been called upon to bear such manifold and onerous responsibilities. His highly specialised knowledge is constantly in demand, not only in the engine-room, but in the gunnery, the torpedo and almost every other department of the ship's economy. In every operation of the late war the engineer branch did its work with a faultless efficiency and an unswerving devotion which won generous praise from commanding officers. We have only to read the despatches on Jutland, the Falklands, and other major actions to appreciate the all but predominant *rôle* that was played by the engineer staff of the Fleet. In the Fleet itself, in the dockyards, and in the various departments of the Admiralty, engineer officers now occupy a far more exalted *de facto* status than they have ever held. With all deference to the Board of Admiralty, we venture to maintain that the overwhelming weight of opinion among deck officers of the Navy is against the proposed withdrawal of military rank from the engineers. We notice that a distinguished flag officer, writing to *The Times*, suggests that a needless fuss is being made about a move which is of no practical significance to the officers concerned. That remains to be proved. In any case, it seems to us to be a very short-sighted view of the matter. If engineer officers are to be formally classed as non-combatants, it follows that their prestige, and consequently their authority, must decline to a greater or less extent. Human nature being what it is, this loss of prestige cannot fail to prejudice their standing with regard to the naval *personnel* as a whole. Since the symbols of executive rank are rightly deemed indispensable to the maintenance of discipline, it is obviously of capital importance to the all-round efficiency of the service that the engineer officer, having regard to his responsible duties, should be invested with the same degree of authority as the navigation, the gunnery, or the torpedo specialist. He is, no less than they, an integral unit of the military organisation, as distinct from the non-combatant medical and accountant branches. It is therefore not as a question of personal or professional dignity, but as a matter of real moment to the welfare of the Navy, that we would urge the Board of Admiralty to reconsider its unfortunate decision. No case has been made out, none has even been stated, for the proposed change. Through the laconic medium of a Fleet Order, of which few outside the service have any cognisance, a reversal of policy which is certain to have a far-reaching influence on the efficiency of the Navy is casually announced. We are well aware that the Navy takes pride in its traditional silence, but there are occasions when reticence can be carried too far, and this is one of them. We hope that the protest made by Lord Weir and his associates will be taken up officially by the powerful institutions which look after the interests of engineers. The profession has the right at least to ask for an explanation of this singular and, to all appearances, ill-advised repudiation of the Selborne scheme.

A special object of the Selborne scheme was to ensure that junior (E) officers should obtain their step in rank at the same age as deck officers, and should, further, enjoy equal opportunities of accelerated promotion according to the classification they received at their previous examinations. For the moment, however, we shall confine our protest to the broader grounds of national expediency. In the preamble to the Selborne memorandum it was laid down that "the strength which its unity gives to the service can hardly be overestimated, yet in respect of this very matter a strangely anomalous condition of affairs exists. The executive, the engineer and the marine officer are all necessary for the efficiency of the Fleet, they all have to serve side by side throughout their career, their unity of sentiment is essential to the welfare of the Navy." In our judgment, the Admiralty's proposal to abolish the military rank of engineer officers, and thrust them back to the inferior status of 1902, strikes at the very root of this principle of unity of sentiment to which a former Board—inspired by the sagacity and vision of Lord Fisher—attached cardinal importance. If, however, the Lords of the Admiralty have sound reasons for their action, it lies with them to communicate those reasons without delay.

The Steam Locomotive.

IT is sometimes said by those who have not given sufficiently detailed attention to the subject that the steam locomotive shows less development than other machines, and that locomotive engineers are by nature conservative and reluctant to give a fair trial to new inventions. The remarkable history of the steam locomotive which Mr. Ahrons brings to an end in our columns to-day should do much to correct that erroneous belief. It is true that the steam locomotive has not altered radically in type since the Planet took the rails, but one might say with equal truth of nearly all other machinery that it remains to-day fundamentally the same as it was after it had passed from infancy to adolescence. The hydraulic press, the steam hammer, the lathe, the planer, the slotting machine, cranes of all kinds, dozens of other machines, and engines of all sorts, all exhibit the broad characteristics of early examples and display no more radical departure from the primary type than is seen in the steam locomotive. The fact is quite the reverse of the censorious

opinion which we have indicated. Throughout the hundred years that have passed since railways became an economic factor of the first importance in world affairs, locomotive engineers, whether the servants of the railway companies or private makers, have shown unceasing endeavours to fit the locomotive for increasing duties and changing conditions. One has only to read those parts of Mr. Ahrons' articles which deal with the history of details, parts which we ourselves have found even more interesting than the accounts of engines themselves, to appreciate the unceasing endeavours of engineers to correct faults, to overcome obstacles—as in the transition from coke to coal firing—and ever to make the locomotive a machine more perfectly fitted to fulfil its vocation.

The locomotive stands almost alone in certain ways. Its lateral dimensions are strictly confined by the gauge of the railway, and its weight is limited by the condition of the road and bridges at any given period. Thus it has presented peculiarly fascinating problems, and by reason of the restrictions under which it has to work has always called for mechanical practice and design of the highest order. Moreover, it has always been controlled by the unwritten law that above all else it must be reliable. To this law engineers have had to sacrifice a good deal. It has exercised a restraining force and its influence has resulted in that caution on the part of locomotive superintendents which is sometimes mistaken for conservatism. Other engines may break down with but little consequences, but if a locomotive fails in service it may cause widespread dislocation throughout a large railway network. Another factor in the design of locomotives which reformers are apt to overlook is that of maintenance. The general manager is much more concerned with economy than with efficiency, and impresses that fact on the chief mechanical engineer. Economy and efficiency are far from being synonymous terms. Many of the devices that have been suggested for locomotives and even tried, as Mr. Ahrons' history shows, increased indeed the efficiency as measured in pounds of coal burnt per ton-mile, but if, on the debit side of the balance, they caused high upkeep costs or through lack of perfect reliability caused engines to spend more than their proper time in the "stable," they were doomed. With the locomotive, far more than with stationary engines, it is impossible to postulate success. No improvement, howsoever promising it may appear upon paper, and however seductive the results of trials may be, is proved sound until it has been many months at work, and the results of its use have been balanced with the cost of upkeep and the delays it may have caused. Furthermore, as we have so often insisted, the locomotive must not be regarded alone. It is part of a system, not an isolated unit. It must be considered in connection with the road upon which it has to run, the nature of the traffic it has to handle, the coal it has to burn, the water it has to consume, the men that may be called upon to operate it, the facilities that exist for maintenance and repair, and even the climatic conditions of the country in which it has to work. All these factors and not a few others have to be considered in the design of the locomotive steam engine. When this diversity of influences is borne in mind, we should rather be surprised at the astonishing progress that has been made in the hundred years covered by Mr. Ahrons than despondent about its progress or hypercritical because it has not changed radically from the form which the engineers of eighty or ninety years ago gave to it. They built on elemental principles, and no attempt—and there have been several—to depart from those principles has been permanently successful.

But whilst the steam locomotive remains in its essential arrangements the same as it was very many years ago, it must not be imagined that it has made no progress save in size. It is true that maximum speeds have not appreciably increased, but loads have more than doubled and the consumption of fuel has materially diminished. Not many years ago between forty-five and fifty pounds of coal per express train mile was a fair consumption for trains of one hundred and fifty tons; nowadays we are approaching as general practice a consumption of forty pounds for trains of twice that weight, and Mr. Maunsell has recently recorded the remarkable figure of thirty-five pounds; whilst Mr. Collett claims for his engines a thermal efficiency of over eight per cent. With such facts before us, it is unfair to take a pessimistic view of the work of locomotive engineers. Every page of Mr. Ahrons' history exhibits the never-ceasing endeavours of engineers to make the locomotive better, and shows how they have, step by step, succeeded. The same energy is still displayed, and year by year we see the result of some improvement, some advance made either by the chief mechanical engineers of our great railways or by the locomotive builders of this country who have carried the fame of the British locomotive into the furthest corners of the earth. The history which Mr. Ahrons has so well recorded is one of which the country may be justly proud, and one which disposes of the criticism of those who, with insufficient knowledge of all the facts, have said hard things of steam locomotive design.

Literature.

The Romance of Navigation. By Captain W. B. WHALL. Edited by FRANCIS E. MCMURTRIE, A.I.N.A. Foreword by Captain E. R. G. R. EVANS, C.B., D.S.O., R.N. London: Sampson Low, Marston and Co., Ltd. 16s.

"WHEN I was asked," wrote the late Captain Whall in his preface, "if I could tell a would-be reader where he could find a book on the history of navigation, I had no answer. Thinking of this, it seemed to me that such a book ought to be written. . . . On further thought, I felt that, if written, it should be popular and not burdened with too much detail."

These words summarise the book. It is a concise history of navigation and maritime discovery from the earliest records of ancient Egypt and Chaldea to our own times. It is admirably written and full of interest, coming, as it does, from the pen of one who was both a practical seaman and an artist in literature. The only fault to be found with it—if, in view of the preface, it can be called a fault—is that it is "burdened" with too little detail. It gives the impression that the author was determined to compress the whole history into one volume, even if he had to pack adventure on adventure, discovery on discovery, like so many pages from "Orlando Furioso." Many a famous voyage is dealt with in a few paragraphs, history-book fashion, leaving the reader, if he has any real love for the sea, wishing to know a great deal more than the bare facts, wanting some more of that "romance" which the title of the volume suggests.

But, taking into consideration the amount of information that is contained in the book, it would be difficult to imagine it better handled. Nothing in the whole history of navigation seems to have escaped the attention of Captain Whall. Discovery is, of course, the keynote, and we sail with all the great discoverers from the time when the ships of Prince Henry the Navigator first ventured out upon the "Green Sea of Darkness," to this twentieth century, when, the rest of the world being known, the adventurer looks to the frozen regions of the poles. But there are many other aspects besides—piracy, slavery, smuggling, hidden treasure and the exploits of the privateers all being dealt with.

Perhaps the most interesting chapters are those at the latter end of the book which take us away from historical facts and figures, and show us something of the actual ships in which the discoverers sailed, and the means by which they were enabled to navigate them to far-distant lands. Here we learn, also, something of the men who worked these ships, their customs, terms and songs, and the legends and mysteries of the ocean. We make the acquaintance of the Flying Dutchman, and learn such quaint natural history, as that petrels "make no nests because they have no feet, and the hen lays her eggs on the back of the cock, and there hatches them."

A very interesting chapter, also, is devoted to the instruments used in navigation, with special reference to the chronometer and its predecessors. The first successful instrument for keeping exact Greenwich time at sea was tested in 1761 on board H.M.S. Deptford. Its usefulness was brought home to the commander of the vessel when he discovered that, had it not been for the machine, he would altogether have missed the island of Madiera, at which he was to call, "the consequence of which would have been inconvenient as they were in want of beer."

"The Romance of Navigation" deserves to be read and re-read, and should fill admirably the place for which its author intended it. With the passing of Captain Whall on the last, long voyage, the nation has lost a fine writer—one who had a great knowledge of ships and seamen as they were in the glorious days of sail, and as they will probably never be again.

SHORT NOTICES.

Les Mechanismes. Par G. H. C. Hartmann. Paris: Librairie J. B. Baillière et Fils. 1925. Price 60 francs.—Those who are familiar with "Willis" need no further description of this volume, for it is practically our English friend in a French costume. Mr. Hartmann divides his subject into six parts. He leads off with a general survey of the geometry that is needed for the study of kinematics of machinery, in which is included the principles of pure geometry, the theory of vectors, and the theory of movements. Having laid down in this manner the fundamentals, he devotes the remainder and by far the larger part of the volume to a description of the many mechanisms known to mechanicians, and the principles underlying their action. Whilst there is nothing novel in the author's method his work is clear and intelligible. We must regret, however, that he did not read his proofs with a little more care.

The Saw Doctor's Handbook. By Drabble and Sanderson, Ltd., Elect Works, Sheffield.—This little book is somewhat in the nature of an advertisement, but it deals with a subject concerning which so little has been written that it deserves a place on any practical man's bookshelf. Doctoring saws, that is to say, reconditioning them so as to get the utmost service, is a highly skilled art, but with the help of the hints given in this handbook, a man, with patience, should gain some aptitude in handling that very untractable material—thin sheet steel, tempered. The book deals with all the processes necessary in the care of machine saws, circular, band and straight, but is not concerned with hand saws.

Copper. By N. E. Crump. London: William Rider and Son. 1925. 10s. 6d.—A very readable volume concerning the metal copper as it affects industry in all directions (and it would have been even more readable had the proof sheets been more carefully revised). It is not a highly technical work, although it is obvious that the author is thoroughly *au fait* with his subject. The book, as it stands, would be admirable as a first study for a mining or metallurgical student, and might, on revision, with a few more illustrations and technical details, be classed as a standard work on the subject.

BOOKS RECEIVED.

Marine Diesel Oil Engines. Second edition. By J. W. M. Sothern. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 42s. net.

Manual of Electrical Undertakings. Vol. XXVIII. 1924–1925. London: The Electrical Press, Ltd., 13–16, Fisher-street, W.C. 1. Price 35s. net.

Jane's Fighting Ships, 1925. Edited by Oscar Parkes and E. McMurtie. London: Sampson Low Marston Company, Ltd., 100, Southwark-street. Price 42s. net.

Report on the Economic Situation in Angola. By A. B. Hutcheon. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. 6d. net.

High Vacuum Surface Condensers. By O. T. McHutchison. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

The Measurement of Humidity in Closed Spaces. Special Report No. 8 of the Engineering Committee of the Food Investigation Board. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. net.

Concrete, Plain and Reinforced. Vol. I., *Theory and Design of Concrete and Reinforced Structures.* Fourth edition. By F. W. Taylor, S. E. Thompson and E. Smulski. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 40s. net.

Report on the Economic and Financial Conditions in Germany. By J. W. F. Thelwall. With a *Report on the Industries of the Occupied Territories.* By C. J. Kavanagh. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 5s. net.

SIXTY YEARS AGO.

IN our issue of December 8th 1865, Mr. William S. Longridge, of the Aldermasley Ironworks, Ambergate, Derbyshire, took us to task for having stated that the first rails made in England or Wales were rolled at the Penydarran Works, near Merthyr. Mr. Longridge claimed that the first rail ever made was produced at the Bedlington Ironworks, Northumberland, and that from these works a staff of men was sent to Penydarran "to teach the Welshmen to make rails." The Penydarran works began operations in 1782, and reached the height of their prosperity in 1845 when, with seven furnaces in blast, they had an output of finished iron amounting to 25,000 tons a year. Thereafter they fell on bad times, and in 1865 they presented a picture of desolation and were at a complete standstill. They had, however, recently been purchased by Mr. Richard Fothergill, and it was anticipated that they would soon experience a revival of activity. Our statement that the first rails made in this country were produced at Penydarran, was accompanied by another statement to the effect that the first locomotive ever constructed in Great Britain was also made at these works. This engine was made, so we said, by Trevithick and Vivian in 1804, and was employed to carry manufactured iron from the works to a basin on the Glamorganshire canal, about nine miles away. In its construction it reproduced several of the features embodied in a working model of a steam carriage made in 1784 "by Mr. Murdock, an engineer in the employ of Messrs. Boulton and Watt." Mr. Longridge did not challenge our remarks regarding this historic locomotive. They were, in fact, substantially correct. . . . In the same issue we reported that a mortar boat which had been lying afloat in Portsmouth Harbour for some months had been docked in order to discover how various preservatives and anti-fouling compositions with which her hull had been coated had withstood the test of time. Of the anti-fouling compositions all, excepting one, a preparation containing mercury, had utterly failed to prevent the growth of marine matter. Among the preservatives, we singled out for special mention Captain Cowper Coles' method of applying a ¼in. layer of cement to the hull below the water line. Under this scheme thin iron plates gashed with small upstanding tongues were screwed to the hull and over them the cement was plastered. It was found that the cement had withstood the test very well. It was intended that sheet copper or anti-fouling composition should be applied to the outside of the cement layer. Among the advantages claimed for the idea was that the cement layer would prevent the setting up of galvanic action between the iron plating of a ship and the copper or other non-ferrous sheathing applied to the hull.

The Smithfield Club Show.

IT is not easy to say something fresh about the exhibits of machinery at the Smithfield Club Show, which opened at the Agricultural Hall on Monday and closes to-day (Friday); but it is noteworthy, this year, that both exhibitors and visitors are more optimistic than for some time past. This is all the more remarkable in view of the restrictions on the movement of cattle, which the outbreak of foot-and-mouth disease has necessitated. It may be that, as a consequence, the visitors were attracted more than usual to the mechanical exhibits, but whatever the cause, there was a distinct air of cheerfulness about the engineering side of the Show.

The time seems now to have gone past when one might expect to find many striking novelties at the "Cattle Show," as even the battle between the steam and the internal combustion engine for the favour of the agriculturist looks like resulting in a draw, with each side well established in different fields, and there is little fear of electric power being adopted on a large scale by our farmers for some time to come. In the circumstances we were quite prepared to find in the hall a number of familiar machines, and we will not tire our readers with a long catalogue of exhibits, which have been already described in THE ENGINEER. In the Gilbey Hall, where the lighter machinery is shown, we found, however, one or two more novel machines, and we will start our account with some notes on them.

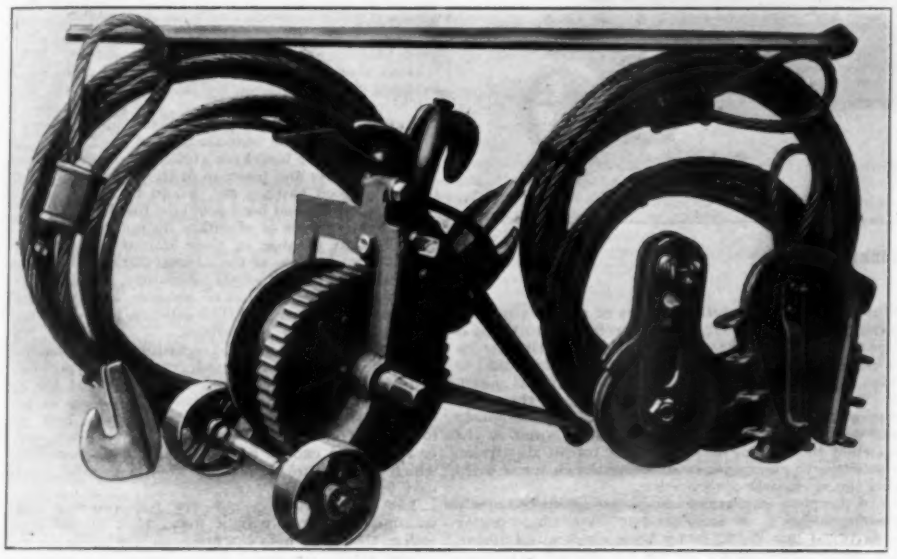


FIG. 1—MAN-POWER STUMP PULLER—TREWHELLA BROS.

The stump puller illustrated by Fig. 1, which is by Trewhella Bros., of Island-road, Handsworth, Birmingham, is an Australian invention and embodies several ingenious devices. As will be seen, the gear

FIG. 2—TREE UPROOTED BY TREWHELLA STUMP PULLER

comprises a simple ratchet winch, a snatch block and the necessary rope tackle for fixing it between the tree to be uprooted and any convenient anchorage, such as another adjacent tree. The drum of the winch, which is 10in. in diameter, has a ratchet wheel 14in. in diameter, and is driven by a double pawl and tumbler spindle. The thrust of the pawls against the spindle is not taken by ordinary bearings, but is transmitted to the framing through a rocking sector-shaped piece, so that rubbing friction is almost entirely eliminated and a very powerful leverage is obtained. It is, in fact, possible to get a pull on the rope of about 13 tons with two men working the lever. The rope is ¾in. in diameter and there is room on the drum for a length of 48ft. For heavy pulling, the rope is led through the snatch block, which is provided with a very simple and safe catch, and back to the anchorage, so that a double purchase is provided and a pull of 24 tons is obtained. The main pulling rope must, of course, be adjusted for length to suit the distance away of the tree to be pulled out, and an ingenious form of grab is provided for its attachment to the winch in such a manner as to avoid damage to the rope through knotting. It takes the form of a hollow grooved steel casting, inside which there is slipped a grooved wedge piece with a semi-circular back. The rope is passed right round the back of the wedge and the pull consequently forces the wedge tightly into the casting. The rope is gripped in the grooves so firmly that it will part before it will slip, but is not damaged by the grip. When the pull is relaxed the wedge easily comes out and releases the rope. Some impression of the powerfulness of this tackle can be gained from Fig. 2, which shows a hardwood tree recently uprooted with it near Birmingham.

On the stand of Alfred Herbert, Ltd., Coventry, there is a "Pipe Pusher" of American origin. It is intended for pushing pipes directly through the ground and is operated by hand ratchet gear. Along the base there are cast two racks, which mesh with pinions mounted in a travelling carriage. These pinions are operated by ratchets and a long hand lever, which can be arranged to give a movement forward of either ¾in. or 1in. for each stroke of the lever. It is claimed that a force of 10 tons can be attained by one man. The carriage is, of course, used to force forward a pilot and subsequent lengths of pipe as the work proceeds. The pilot is of a peculiar form and has a small cup in the nose, which is said to enable it to pass large stones without deviating from its course. The makers state that an average speed of progress is 40ft. an hour.

The little pump, by Boulton and Paul, of Norwich, shown in Fig. 3, is made in several sizes for duties ranging from 400 up to 7500 gallons per hour. Its chief feature is the method of oiling, which is worked on the splash principle. The crank case is cast in one with the frame and provides an oil well into which the excentric driving the bucket dips. The gear wheel, with which it is driven by the motor, also runs in the oil and throws some up into a duct that leads it to the crosshead. The cylinder is a separate casting, and is brass lined, while the valves are of rubber working on bronze seats. All the valves are easily accessible without disturbing the pipe work. The castings of this pump are machined at one setting, so that the proper alignment of the running parts is ensured.

In the main hall the exhibits are, as we have already suggested, very similar to those of past Shows, but we noticed some minor modifications. In the case, for instance, of the petrol ploughing engine by McLaren's, of Leeds, shown in Fig. 4, the petrol tank has been rearranged so that it can be fed by gravity from the supply wagon. A hand pump is then used to raise the petrol to another tank high enough to allow it to flow down to the carburetter. A screw tackle, hung from the canopy, has also been added to facilitate the removal of the cylinder heads.

The chief reason why we have included Fig. 4 in this notice is, however, the good way in which it illustrates the ability of the machine to work on uneven ground. As will be seen, the engine is lying half in a ditch and the rope leads in at a sharp angle, which would result in very awkward coiling on the horizontal drum of a steam set. In the case under review, however, the rope runs over a large guide pulley in the centre of the frame and is wound on a separate vertical drum placed at the back of the machine. The result is that whatever may be the angle at which the rope approaches the machine it is wound equally on the drum without riding turns.

Marshall, Sons and Co., of Gainsborough, have a stand, in their usual place near the corner, on which there is exhibited a group of oil engines, including sets of 8, 12, and 25 horse-power, a 7 nominal horse-power single-cylinder traction engine, and a 4ft. 6in. thrashing machine, which is now fitted with ball bearings to all the running shafts. The 4ft. 6in. thrasher shown by Ruston and Hornsby, of Lincoln, is also fitted with ball bearings to the drum shaft, cranks and all fast-running spindles. On this stand there is also a number of oil engines of the airless injection, cold starting and medium compression types, the characteristics of which are familiar to our readers. They range in size from 6 up to 45 horse-power and are accompanied by several smaller paraffin engines, pumping sets, and so forth. John Fowler and Co., of Leeds, again have one of the most brilliant electric signs in the Show set up behind a compound steam ploughing engine, a four-furrow

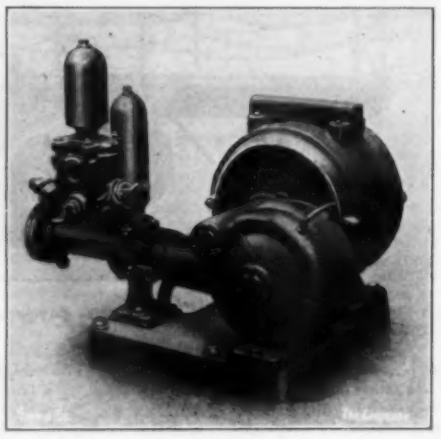


FIG. 3—MOTOR-DRIVEN PUMP—BOULTON AND PAUL

anti-balance plough, and a two-shaft reversible discer capable of working a width of 11ft. There is also on this stand a 6–7-ton steam wagon with a three-way tipping body. It is equipped with a Vee type engine, arranged under the driver's seat, and has a worm drive with a three-speed gear-box. Close by there is the stand of Clayton Wagons, Ltd., Lincoln, on which the most novel item is the introduction of four-wheel brakes on a steam wagon—the first example, we believe, of such an arrangement. The brake drums on the front wheels are attached to the spokes near the rims and are consequently of a good diameter, so that the braking on all the four wheels can be properly equalised. In support of our suggestion that the exhibitors are optimistic, we may say that we heard that this firm's forge is working night and day at full capacity.

The most novel exhibit on the stand of Tangyes

FIG. 4—PETROL PLOUGHING ENGINE—McLAREN

Ltd., Cornwall Works, Birmingham, is a six-stage turbine pump, one of a group of seven new models made for heads up to 210ft. and capacities of 1500 gallons per minute. The impellers of these pumps are of the single inlet type and the end thrust is taken by an automatic balancing disc. A small matter, but a useful one in dismantling operations, is the provision of lugs on the outside of the casings, so that they can be temporarily bolted together and the main through bolts slacked off. The casings can then be taken apart or put together individually.

W. Tasker and Sons, of Andover, Hants, have a steam tractor and a new type of two-wheeled trailer capable of taking a load of 1 ton. It has 4½in. pneumatic tires on steel disc wheels and semi-elliptic springs. The body is of steel and the total weight is 7 cwt. An unusual feature about this trailer is the method adopted for connecting it with the towing vehicle. The device takes the form of a ball and

socket joint, of which the female part is hinged, so that it can be opened for the insertion of the ball. The two parts can be closed together by means of a cam and lever sufficiently tightly to prevent the ball being pulled out by the tractive effort, but still allow freedom of movement in all directions.

Fodens Ltd., of Sandbach, are showing a 6-ton steam lorry almost identical with that illustrated by Fig. 5, one of the chief peculiarities of which is the

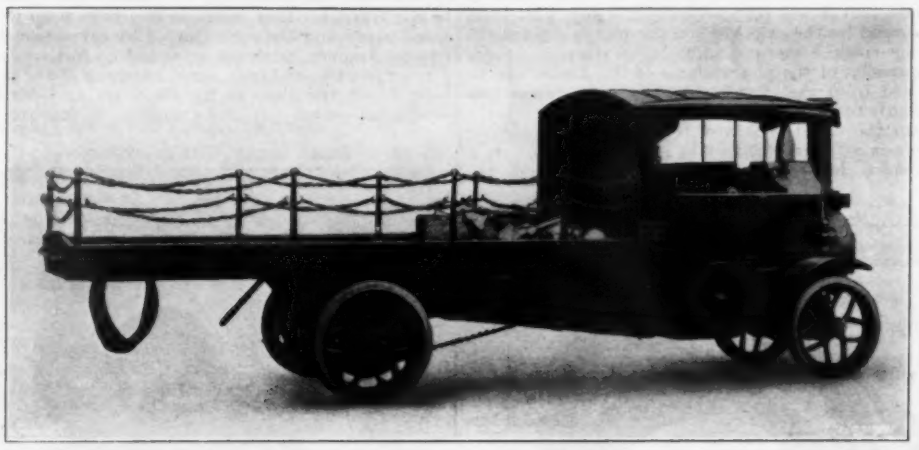


FIG. 5—6-TON STEAM LORRY—FODENS

provision of Ackermann steering gear. The weight of the front end of this machine is carried by a transverse spring above the axle, which results in a three-point system of suspension, and the load is taken by a separate framing, instead of being transmitted through the smoke-box of the boiler, as is the case with some machines with locomotive type boilers. We have already dealt thoroughly with the steam wagon made at Leiston by Richard Garrett and Sons and thus need not enlarge upon it here, but it is noteworthy that it is now fitted with a dynamo driven directly off the engine with no intermediate gearing, for providing current for the head lamps. Incidentally Garrett's are making their own lamps of cast aluminium.

On the stand of William Foster and Co., Lincoln, Sir William Tritton showed us an insurance company's certificate which he had just received. It concerned a 5-ton compound steam tractor which had been in service for fifteen years and had been examined for re-insurance. The fire-box was the one originally fitted and had not been repaired in any way. The permitted steam pressure was, nevertheless, fixed again at the original amount of 210 lb. per square inch. On the same stand we inspected a very ingenious little mechanical oil pump for lubricating purposes. In it the plunger is raised by means of an excentric worked by a normal ratchet motion. The excentric is, however, loose on the shaft and is driven by means of a pin bearing against a projection. On the outstroke the plunger compresses a powerful spring and as soon as the dead centre is passed the spring shoots the plunger forward, carrying the excentric round ahead of the shaft. The effect of this rapid delivery stroke is that slight leakages past the plunger are immaterial and the pump will, we are told, deliver paraffin against a pressure of 400 lb. per square inch even when a $^1/_{32}$in. flat is cut along the plunger.

Blackstone and Co., of Stamford, have a fine show of their familiar oil engines, but one of the most interesting exhibits on the stand is a new type of mowing machine. In the place of the usual crank and connecting-rod for reciprocating the cutter blade a mechanism after the fashion of a swash plate has been adopted. The result is that a much more direct thrust is given to the blade and all the gear can be boxed in for lubrication. We understand that the use of this driving gear has reduced the draught necessary to work these machines by 25 per cent. as compared with the ordinary mechanism.

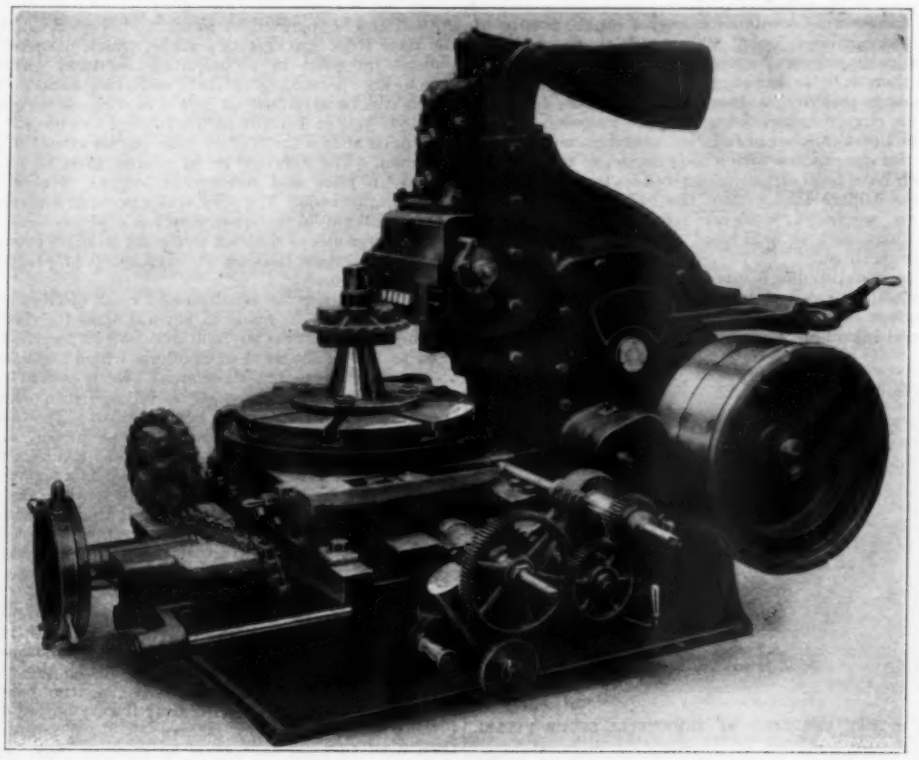
Among the other exhibitors in the main hall there are William Allchin, Northampton, with a steam wagon fitted with a tipping body; Aveling and Porter, Rochester, a couple of agricultural tractors; Charles Burrell and Sons, Thetford, a steam wagon; J. and F. Howard, Bedford, a tractor and various agricultural implements; Petters Ltd., Yeovil, various sizes of oil engines; Ransomes, Sims and Jefferies, Ipswich, agricultural implements, including a special plough for lifting sugar beet, and a portable oil engine. E. R. and F. Turner, of Ipswich, have typical examples of crushing and grinding machinery, and Wallis and Steevens, of Basingstoke, a traction engine and a spring-mounted steam tractor. We will not attempt to deal with the exhibits in the galleries, as they are almost without exception implements and such like apparatus chiefly of interest to agriculturists and dairymen.

Improved Spur Gear Generating Machine.

THE accompanying illustration depicts a spur gear generating machine, built by Wm. Muir and Co., Ltd., Manchester, and specially adapted for generating the teeth of chain sprocket wheels. Several rather important improvements have been effected in the construction of the machine since it was last the subject of a notice in THE ENGINEER, May 26th, 1922. Before referring to these it may be advisable to state briefly the main principle on which the gear cutting is effected. The blank is caused to roll along the cutter, which has a simple vertical movement. When the wheel or blank has rolled along the cutter a distance equal to the pitch it drops back instantaneously parallel with the cutter through a distance equal to the pitch, while the cutting tool is at the top of its stroke, without either the necessity of stopping the cutter or withdrawing the work clear of the cutter.

One of the most important improvements in the newly designed machine is its arrangement for a single pulley drive from the line shaft, or by a constant speed motor, gearing being provided for giving the desired variations of working speeds. The feed gearing is now totally enclosed, and, together with the driving gears, runs immersed in oil. The ram or tool-box slide has been completely re-designed, and consists, of a heavy iron casting to the back of which is secured a cast steel toothed rack. The method of attachment is by means of long T nuts and screws shown at the front, this form of construction acting as a safety device to prevent the breakage of cutters. It will be noted that the front surface of the ram is machined on an incline, and upon this the cutter box is carried, the latter now being provided with automatic relief mechanism, which prevents the dragging of the cutter against the work on the upstroke of the ram.

To adapt the machine to the generation of the teeth of sprocket wheels as shown, no alteration of the machine was necessary beyond the provision of a special cutter, whatever pitch is required being obtained from a pitch lever without the use of special gearing.



SPROCKET WHEEL GENERATING MACHINE

The Scientific Basis of Industry.*

By FRANCIS H. CARR, C.B.E., F.I.C.

JUDGED by the achievement of engineers and chemists trained by the methods initiated by the City and Guilds there is ample justification for claims made for the value of science in industry, but there is danger that we may assume that a particular training is the only one that industry requires in its recruits.

As far as chemistry is concerned, we have built too hurriedly on the assumption and have proceeded to train men of one type, giving too little attention to the question whether chemistry can successfully be applied with the assistance of one type only or whether it is desirable to use more than one.

As one of Streatfield's pupils, I wish to raise in others the doubt whether our educational system is not open to the criticism that it produces more trained chemists of a certain type than our industries can absorb, and yet fails to produce enough of another kind greatly needed by the industry and on whom the employment of the usual type of trained men largely depends.

We have met the complaint that introduction of the university man into the works causes dissatisfaction, that apprenticeship produces men more suited to the employer's needs than does the university, and the trained men complain that they are confined to the laboratory. For many reasons there is a pressing need to find some means of bridging the gap between the laboratory and the works.

There are few industries, if any, which do not need better technical achievement while in many more efficient production and better standardisation will bring greater prosperity, higher wages for workers and increased employment. Manager and foreman of the self-educated apprentice type, good as they are, would be more successful if better education had been provided for them.

Greater numbers of chemists do not become managers and foremen because of their impracticability for production, not because of the natural distinction between an academic and an industrial laboratory, though it is often a fault of this former that its *habitués*, seeing no necessity for monetary outcome of their labours, look down on those engaged in such practical affairs.

The view here put forward regarding established methods of chemical education is contrary to the hypothesis that education in this country is doing the best for applied chemistry. University and college training in physics, chemistry and mathematics provides the best general foundation for a career in any branch of science, and three or four years can at best provide only a foundation on which a structure of special knowledge and experience may be erected afterwards.

The statement that industry requires men of broad training in science cannot mean that in the period of college training a man can abandon specialisation, because almost always successful study cannot be achieved unless the students' main interest is confined to a comparatively narrow field as, for instance, chemistry or physics. The question of specialisation becomes one of degree, *i.e.*, the number of subjects, their variety and relative preponderance.

There is a strong tendency to train for the industry one type of chemist whose training consists of chemistry, physics and mathematics, and when this is followed by one or two years at research its character does not usually take the student outside the same field of study. Such training may be the best for most men seeking careers in chemistry, but it is not the best for all types, and it does not form the best starting point for all kinds of posts in the industry.

Some men possess the instincts of a technologist, to

* Extracts from the Streatfield Lecture delivered at the Technical College, Finsbury, on December 3rd, 1925.

whom mathematics beyond early stages is anathema, who can only take remote interest in the theory of light or the constitution of the atom, but who takes keen interest in the problems of applied mechanics, the transference of heat, &c., men who cannot compass the abstract, but delight in the practical and who may become first-class industrial thinkers and leaders. This kind of man is extraordinarily successful in chemical technology, developing sound judgment, clear perception, and a sense of proportion.

Many agree that we suffer in this country from a lack of men specially trained for chemical engineering. Men of the kind I have just referred to and others wishing to devote themselves to factory life could meet this need if trained in a curriculum where the physics and chemistry were of a more practical type than that suited for the university examination syllabus subsequent to the intermediate science standard. After this a foundation suited to the training of a chemical engineer should be laid, since the training at present dictated by examination syllabuses is not best suited for this purpose.

We need to exercise great care in providing our youth with the right facilities for cultivating at this stage the best that is in them. Opportunities to develop chemical engineering during the years immediately following college training are very few because the college foundation has not been suitable. For this reason employers will not allow the men to take part in actual manufacture, and mostly they regard the young graduate as not only unqualified for such work, but as definitely unsuitable for it, and his activities restricted to the laboratory.

I greatly deplore the present tendency to regard the attainment of a degree as an end in itself, implying qualifications for earning a living.

While much may be said for a training in research in preparation for industry, it is not correct to say that this course is the best preparation irrespective of a man's abilities on the career he may afterwards follow. Often research does not awaken that keen enthusiasm and absorption without which it is a poor method of training, accompanied by waste of money and loss of opportunity at a time when it is good for the student to face drudgery and learn to persevere with monotonous tasks. Apart from educational value, the ultimate test of research is whether its application adds to the physical, mental and moral good of humanity, and this object is served by those who apply new knowledge as it is by those who discover it.

In this country we need men who can apply chemistry to industry more than men who will advance our knowledge of the science. England has led the world in chemical science and also in those applications where the work of the engineer is readily divorced from that of the chemist, *e.g.*, in the manufacture of soda and sulphuric acid and, in some respects, in the gas industry, but in organic chemical industries requiring exact methods of control and intricate plant design others have outstripped us because it is essential to have a clear conception of the chemical difficulties and the mechanical devices for overcoming them.

There are problems in which the work of the chemist and engineer cannot be divorced, and there is at present serious lack of men trained as chemical engineers capable of solving the problems of setting up new manufactures and revolutionising the established ones. Combined training in chemistry and engineering has been given in this College since its inception, and its students are still keenly sought after in the industries. There is abundant evidence of the achievement of chemists who received their early training in chemistry with engineering as a subsidiary subject at the Finsbury Technical College.

At the time that Finsbury Technical College is about to be closed there is need for chemical engineering training on a scale adequate for our requirements, not, be it understood, a continuation of what has been done there, but a great and new development of it requiring adequate buildings and endowment and a joining of forces of all who wish to solve a great and urgent problem.

Such an advance would be comparable to, but greater than, that of the City and Guilds in founding colleges of mechanical and electrical engineering, and I believe the Council of the City and Guilds of London Institute will give favourable consideration to any scheme which promises reasonable prospects of success.

The laboratories and buildings of the Finsbury College are to be vacated shortly, and it is not impossible that the City and Guilds, in their goodness, would assign these buildings to such a purpose and possibly the Ramsay Memorial Laboratory would collaborate in the development of a College of Chemical Engineering.

ESCALATORS ON THE CENTRAL LONDON RAILWAY.

AT a meeting of the Association of London Students of the Institution of Civil Engineers, held on December 2nd, at six o'clock p.m., Mr. H. F. Molony, Stud. Inst. C.E., read a paper on "Escalators on the Central London Railway." The chair was taken by Mr. G. W. Humphreys, C.B.E., M. Inst. C.E., chief engineer of the London County Council.

Mr. Molony commenced with a description of the escalators at Liverpool-street Station, which were the first to be installed on the Central London Railway. Four were constructed in 1920, and a fifth has since been added. He then went on to say that at the Bank Station, in 1923–1924, three escalators were built in one 25ft. diameter tunnel. During alterations to the booking hall, the street above was undisturbed, being supported by the aid of 14in. by 14in. timbers. At Shepherd's Bush extensive underpinning and alterations to the station building were carried out; the lower level escalator chamber, passages and inclined tunnel being constructed under compressed air.

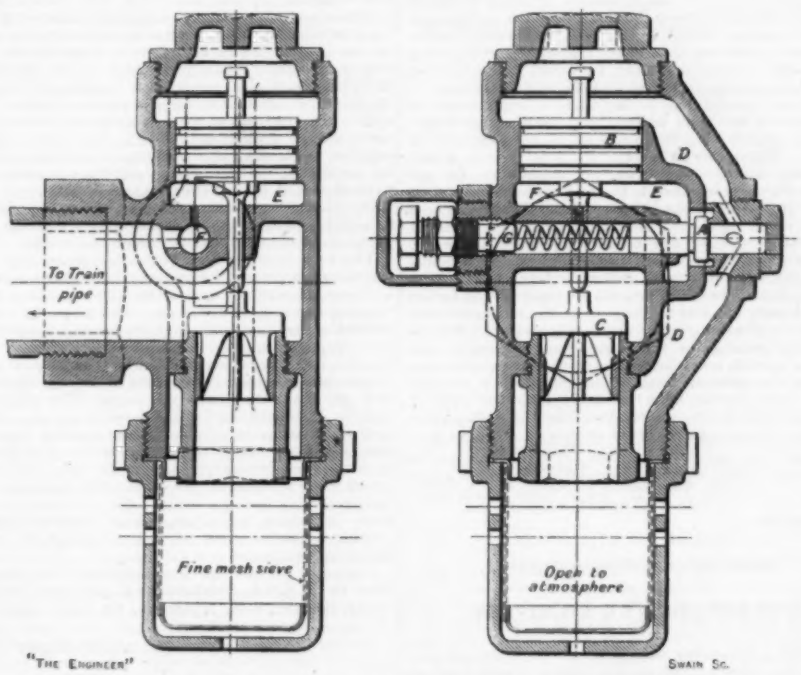
At Oxford-circus the excavation commenced under Argyll-street, the station buildings on each side being underpinned. Owing to lack of headroom, the roof consists of steel troughing supported by girders running across Argyll-street. It was necessary to divert three water mains, some gas mains, and high-tension electric cables. For the new water mains, which were 30in., 24in. and 21in. diameter, steel casings with welded joints were employed, and they were carried between the longitudinal girders running parallel to, and beneath Oxford-street. At Bond-street, the last station dealt with, much underpinning was necessary. The new foundations were carried down to London clay. Here some of the work was carried out under a pressure of 15 lb. per square inch, in order to prevent any settlement above and consequent damage to buildings.

In conclusion, the author gave some account of the restrictions under which the work was done, but for which the time taken would have been reduced.

Reducing Valve for the Vacuum Automatic Brake.

A NEW type of reducing valve made by Gresham and Craven, Ltd., Manchester, for use with the vacuum automatic brake is now being tested on some of the railways in this country and in India. The object of the valve is, first, to assist in maintaining a uniform working vacuum on all trains in a group of railways, and thus prevent the delays that are sometimes caused by the reducing valves on one section or any particular engine being set for a higher vacuum than is usually carried; and secondly, to overcome the difficulty experienced by the use of the ordinary type of "pop" reducing valve which can only maintain the desired vacuum against a given size of ejector. The large ejector, which is used for releasing the brake quickly, overcomes the reducing valve that is set for the small ejector used for maintaining the vacuum throughout the brake system and, if not shut off in time, it produces a higher vacuum than the small ejector may maintain; consequently the brakes "creep on" when the large ejector has stopped working, and then the brakes have to be released by hand. On very long goods trains where it is desirable to work with a comparatively low vacuum this trouble is accentuated.

Another advantage claimed for the new type of reducing valve is that it enables the ejectors to release the brakes more quickly, as it does not begin to open until the predetermined vacuum has been reached. In this respect it differs from other spring-loaded reducing valves, which tend to open too soon to a greater or less degree, thus making it very difficult to keep accurately to any desired definite running condition.



REDUCING VALVE FOR USE WITH THE VACUUM AUTOMATIC BRAKE

The action of the new valve will be followed by reference to the accompanying drawing. The amount of air that has to be admitted to reduce the vacuum in the train pipe is controlled by the train pipe valve C, which in turn is controlled by a piston B, the top side of which is open to the atmosphere through the passage D and to the train pipe on the bottom side through the small hole F in the chamber E. The vacuum created in this chamber through this small hole is under the control of a small spring-loaded valve A, the loading spring of which has an adjusting screw G which can be set to open at any desired vacuum and is locked and covered by a cap to prevent it being tampered with. The piston B has a larger diameter than the train pipe valve C, so that a very definite reduction of the vacuum in the chamber E below this piston is necessary before the train pipe valve C can open. Therefore it is not affected by the early opening of the small auxiliary valve A before the predetermined vacuum has been reached, as is usual with spring-loaded valves. This valve must open sufficiently to overcome the vacuum maintained in the chamber E through the small hole F before the vacuum below the piston B can be reduced to a point to give a balanced effect to the train pipe valve C and allow it to open freely to any extent and admit a sufficient amount of air to overcome either the large or both ejectors that may be working. Should the amount of air admitted to the train pipe tend to lower the vacuum, the auxiliary valve A closes accordingly and the vacuum below the piston B is increased until a point of equilibrium is again reached between the piston B and the train pipe valve C to keep the vacuum constant irrespective of the number or size of ejectors at work.

The Productive Capacity of German Machinery Works.

AMONG the various papers presented at the general meeting of the Verein Deutscher Maschinenbau Anstalten, which was held in Berlin on December 4th, was a remarkable report presented by Herr Lange, manager of the Association. It dealt with the economic crisis and the means of meeting it, and showed how the productive capacity of the country, regarded from the standpoint of the number of works in individual branches of machine construction, had greatly outstripped the requirements of the home and foreign markets. This report, we learn from the German newspapers, was received with loud and repeated applause. The author stated that the crisis was now in full swing, and the solution must be of a thorough character, so that the economic body might again become sound. The German machinery industry had admirable prospects in consequence of the industrialisation of many countries, and the necessity which always existed for German production to keep pace with technical development by the improvement of its own machines, but, above all, in connection with the increased adoption of mechanical appliances in agricultural operations.

But the German machinery industry, Herr Lange proceeded to say, was overcrowded. The only possibility of utilising the present productive means lay in the creation of a European Customs Union, but so long as that Union did not exist, it was necessary to restrict the means of production. At the present time, for instance, there were 100 works in Germany which were turning out lathes, whereas the United States managed with one half of that number. As the American market had a purchasing power that was five times greater than that of Germany, Germany should only require about one-fifth of the number of works in the United States, or perhaps 15 to 20 works, taking into consideration the relatively greater exports. The number of wagon works in Germany was now 60, as compared with 40 in 1913, although the Reich Railways were giving out scarcely any orders. Moreover, there were 53 works constructing band saws, whilst 45 turned out circular saws and 28 produced saw frames.

It was necessary to remove the overcrowding by reasonable individual limitation, otherwise the present underselling would lead to the ruin of all. It would only be possible to increase sales by reducing the costs of production. Abroad the rate of interest was 3 per cent., and the stocks held were enough for from eight to fourteen days, whereas in Germany the stocks were sufficient for months with a rate of interest several times higher. In the opinion of the author, the number of works in excess of requirements must be brought to a standstill, written off, and, should the occasion arise, be dismantled. Owing to the multifarious output of the machine industry it was not possible often to effect complete amalgamations, but, already, about 600 machinery works, representing one-fifth of the whole machinery industry, had combined together in the form of 150 communities of interests. By that arrangement, an economy of 23 per cent. had been gained in wages in the paper-making machine branch. A printing machine works, which used to construct 26 kinds of machines according to 115 models, now only constructed a single type in four sizes, and had thereby increased the efficiency by 14 per cent., while at the same time the working expenses had been reduced by from 30 to 40 per cent.

Concerning the bringing about of a reduction in the prices of machines, Herr Lange stated that the industry and other consuming industries required the support of the allied industries, and they therefore welcomed the proposed formation of a steel trust. It was important that, through amalgamations and rational production, the steel industry should become strong enough to carry on in the face of low Customs duties or without any duties at all. The agreement between the steel producing industry and the consuming industries, according to which the former granted to the latter the world prices for materials used in the manufacture of export products,

led to the hope of further co-operation between producers and consumers. But, said Herr Lange, it was an impossible condition for the iron and steel industry to demand payment at thirty days, and at the same time ask for guarantees, while on its part it demanded a credit of one year from the machine works.

NAVAL ENGINEER OFFICERS.

THE following letter appeared last week in *The Times* and the *Morning Post*.

SIR,—The Admiralty Fleet Order issued on Saturday, November 21st, cannot fail to create not only profound disappointment and astonishment in the engineering profession, but must also give rise to grave apprehension in the minds of those who have at heart the best interests of efficiency in our Fighting Services. Apparently without any explanation the Selborne-Fisher scheme, inaugurated twenty-three years ago, under which the status of the engineering officer was fully recognised, has been entirely scrapped.

We do not suggest that the Selborne-Fisher scheme was perfect, or that the modifications made in recent years were not essential, nor do we plead for either the possibility or desirability of an engineer officer taking command of a fleet, but we do feel bound to record the most emphatic protest against a step which appears definitely to relegate the engineer officer of H.M. Navy to the inferior status he held in 1902. To accentuate the difference by decreeing that "a more distinct shade of purple is to be used" would appear to indicate that nothing is to be left undone which will effectively mark the change.

We do not seek to speak for the hundreds of officers who entered the Royal Navy under the scheme, and who specialised in engineering, nor do we require to point out the untarnished record of the engineering side of the Navy during the Great War, which was fought in the engine and boiler-rooms as well as from the conning-tower and the bridge. What is essential to recall, however, is the extraordinary increase in responsibility of those technical officers and the ever growing necessity for the permeation throughout our services of the technical spirit and atmosphere. At no previous time in the history of our Fighting Services was it more necessary to avoid differentiation of status between the executive and the technical officer.

Throughout the Services to-day there is ample evidence of the need for less rigid adherence to tradition and precedent in regard to those appointed to positions of authority. The material for the Navy is now to a preponderating degree engineering in character. In the Royal Air Force, equipment is by far its most outstanding problem, while the mechanisation of the Army proceeds more and more rapidly. Accordingly do not let us at this time adopt without the fullest consideration any step which will affect the status of those on whom our Services are gradually becoming more and more dependent. Anything done to-day to cause parents to question the future status or dignity of a technical career in any of the Services for their sons, anything which appears to detract from the position and prestige of the engineering profession, can only in our opinion react harmfully on the future efficiency of our Services, apart altogether from the effect on existing engineer officers, and we trust that this matter may without delay receive the fullest consideration from the Associations and Societies representative of our profession.—Yours, &c.,

WEIR.
CHARLES A. PARSONS.
ARCHIBALD C. ROSS.
J. E. THORNYCROFT.

December 3rd.

SUPER-HETERODYNE RECEIVERS.

ON Friday, December 4th, Mr. A. E. Bowyer-Lowe delivered a lecturette before the Junior Institution of Engineers, on the subject of "Super-heterodyne Receivers."

Mr. Bowyer-Lowe said that, stated quite simply, the principle on which the super-heterodyne operated was that the wave length of the received signal was changed to some higher wave length, which new wave length was amplified at radio frequency and detected in the usual way. The change in wave length allowed of more efficient high frequency amplification than was possible on the shorter wave length and also gave greater selectivity.

The change of wave length was obtained by superimposing on the incoming signals a current of different frequency produced by an oscillating valve, so that the two trains of vibrations produced a beat note. This beat note had a frequency equal to the difference between the other two frequencies and was usually lower than either of them. Mr. Bowyer-Lowe demonstrated the way in which a beat note was produced by means of organ pipes of varying pitch. He then went on to discuss the choice of intermediate wave length, and mentioned features in the design of super-heterodyne sets which were desirable in order to make the best possible use of the principle involved. He dealt with such parts as transformers, valves and oscillators.

During the discussion which followed the lecturette, Mr. Bowyer-Lowe made clear what the useful function of a super-heterodyne set was. It was not, he said, the type of set to use for local reception nor could it be expected to give reproduction which would be considered entirely undistorted by a critical ear. It was purely for long distance reception, for operating a loud speaker, practically free from distortion, and without interference.

A REUTER'S message from Tokio states that the Japanese Railway Department, after a two years' special test, has decided to substitute British rails for American, the tests having proved that the former are greatly superior and last longer. It is understood that the authorities contemplate complete substitution within the next decade.

NEW BRITISH STANDARD SPECIFICATIONS.

THE British Engineering Standards Association has recently issued Standard Dimensions for Dynamos, Distributor Mountings, Starting Motors and Dynamotors for Automobiles (Publication No. 5031–5034–1925), which are bound in one cover; also Standard Dimensions for Small Couplings for Internal Combustion Engines (Publication No. 5035–1925). The first includes four specifications giving the overall and other important dimensions, which are useful to the designer when arranging the placing of the various accessories in the chassis. It is a publication which should be in demand, and will probably be as much appreciated by the private user and the small garage man as by the manufacturer. When universally adopted it will be possible to replace or interchange the various makes of these fittings without the costly alterations which are generally necessary when another make of dynamo or starter is fitted into a chassis. The fifth specification, that for small couplings (No. 5035–1925) is also dimensional and gives all that is necessary for interchangeability.

The dimensions in the above publications are given both in inches and millimetres. The new standards contained are based upon the provisional Standards Nos. 15, 16, 17, 18, and 19 of the Society of Motor Manufacturers and Traders, Ltd., published in the data sheets of the Institution of Automobile Engineers. They were submitted to the B.E.S.A. for consideration and approval and have now been issued as British standards.

The B.E.S.A. has also published the following new and revised British Standard Specifications:—No. 42, 1925: Reciprocating steam engines for electrical purposes; No. 120, 1925: gas engines for electrical purposes; No. 213, 1925: heavy oil engines for electrical purposes, airless injection, cold-starting type; No. 211, 1925: heavy oil engines for electrical purposes, Diesel type, air injection; No. 212, 1925: heavy oil engines for electrical purposes, surface-ignition type. The specification for reciprocating steam engines is a new edition of the original specification No. 42, issued in 1909. The revision has occupied several years; all the clauses have been modified and brought up to date and a number of additions have been made. The rating of the steam engine is specified as the load in brake horse-power assigned to it by the maker to satisfy the requirements of the purchaser and to comply with the specification; a margin of capacity of 25 per cent. above the rated output is called for. The cyclic irregularity has been defined and limits given and the question of fly-wheel effect is dealt with. Steam and exhaust pressures, standard speeds, speed adjustments for paralleling and governing, and the equipment which is to form part of the standard engine are also given, together with appendices setting forth the particulars which should be supplied to the engine maker with the inquiry and the particulars to be supplied by the engine maker.

The four specifications for gas engines and heavy oil engines were prepared concurrently, and the aim has been to secure consistency and uniformity regarding the salient features as far as practicable. The rating in each case is defined as the load in brake horse-power which the engine can carry continuously for a period of twelve hours at its rated speed when working under the stated conditions of pressure and temperature, and in the case of gas engines, with gas of the stated calorific value. The engine must be capable of developing for one hour 10 per cent. above this rating. Clauses have also been included regarding the selection of the size of engine required to suit the capacity of a specified generator; the cyclic irregularity and the question of fly-wheel; the permissible variation in speed for paralleling and governing; the allowance to be made when an engine is working under non-standard atmospheric conditions; gas or fuel consumption; tests and standard equipment.

Copies of all the above specifications may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. each post free.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HEATLESS COMBUSTION.

SIR,—In my letter of November 16th I showed that my original expression for calorific value given in my letter of October 13th, namely, $Q_{l1} = Q_m^{n} - U_p^{n}$, is identical with $Q_{l1} = U_p^{n} - U_p^{n}$. The definition usually applied is as follows:—

The calorific value is the quantity of heat which must be abstracted from the products of complete combustion of a unit of fuel in order to reduce them to the temperature of the mixture.

The second of the above two equations represents directly this definition; the first equation giving identical values, as I have shown previously, must obviously agree with this definition.

I am afraid that Mr. Walker is too generous in ascribing this definition to me.

I also showed in my previous letter that Mr. Walker's analytical expression for calorific value did not agree with the accepted definition. Mr. Walker fails to bring in agreement his $Q^{n} = U_p^{n} - U_m^{n}$ with his statement of October 24th. In dealing with methods of obtaining the calorific value he referred to exhaust products being reduced to the initial temperature of the mixture, yet there is nothing in his analytical expression representing exhaust products at the temperature of the mixture. Indeed, he now takes the difference of the two constants I used in my first letter, namely, $K_m - K_p$, and calls it the true calorific value. In his letter of November 16th he stated that allowance is made for temperature when establishing the calorific value. His last calorific value appears as the difference of two constants and therefore is constant and independent of the temperature. It appears that the whole confusion was due to Mr. Walker having two different calorific values in mind. It is sufficient, however, to state that his last calorific value is not the calorific value as generally accepted and measured.

It is also now quite clear that whatever Mr. Walker might mean by calorific value, it is quite irrelevant to my analysis of heatless combustion. My equations and analysis stand exactly as I put them in my first letter.

Mr. Walker proceeds to plot adiabatic curves on a p v diagram. I am afraid I cannot accept his adiabatics. We must remember that there is a very definite relation between combustion products and the mixture, in addition to the condition of heatless combustion established in my first letter. There is no indication in Mr. Walker's adiabatics that they do represent actually a mixture which has been compressed to the neutral point and that that mixture has actually heatless combustion. However, the problem has been raised by Mr. Walker to show that the term of heatless combustion, as defined by me, is a misnomer. While I cannot and do not claim having in any way originated "heatless combustion," I think that the term is quite convenient, together with the other two terms "exothermic" and "endothermic." It does not appear clear why the term is a misnomer if in some processes there is, or is not, a surplus of work; but I think you will agree that an opinion concerning merely a term is of no consequence to the problem itself.

In my last letter in equation 5 and 6 I inadvertently took the temperature t_2 for combustion temperature when the mixture was at a temperature of zero; instead of making such assumption, the temperature t_2 should be established from the adiabatic expansion of the combustion products from the neutral point and this temperature would then enable us to calculate the adiabatic work and the heat in the combustion products at the end of expansion. This calculation would have to be done in every case, as it depends on the constitution of the combustion products. I believe that if carried out it would show that generally there is a balance of adiabatic work even in the case of heatless combustion.

In my original letter I showed that the action of hydrogen on carbon dioxide represents neutral combustion at two temperatures. Therefore, if we take 1 kg.mol. of hydrogen and 1 kg.mol. of carbon dioxide as the mixture, and on the other hand 1 kg.mol. of H_2O and 1 kg.mol. of CO as the products of combustion, the adiabatic work can in this given case be established.

As I have already pointed out, whether there is, or is not, a surplus of work, it does not affect the problem of heatless combustion in the sense raised by you.

Mr. Walker takes my conclusion at which I arrived in my last letter in connection with the adiabatic work in a process which involves heatless combustion and applies it to all ideal gas and petrol engines. I am afraid that this is a very remarkable procedure. A conclusion which refers solely to heatless combustion, whether right or faulty, can be applied again solely to heatless combustion and not to exothermic combustion; or does Mr. Walker really think that all ideal gas and petrol engines have heatless and not exothermic combustion? If he does not, or cannot prove it, then it means confusing two entirely different things. That such confusion would of necessity result in faulty formula for the efficiency of all ideal gas and petrol engines is beyond doubt. B. POCHOBRADSKY.

Erith, Kent, December 8th.

HEATLESS COMBUSTION.—In Mr. W. J. Walker's letter in last week's issue the upper limit of the second integral in formula (1) should have been T_1 and not T_2, as misprinted. With this alteration formula (3) correctly represents the combination of formulas (1) and (2).—[ED. THE E.]

COMPOUND LOCOMOTIVES.

SIR,—Some reply is, by courtesy, due from me to the remarks made by Mr. Ahrons and Mr. Brewer.

Mr. Ahrons has pointed out how much both augmented power and economy in locomotives has been due to the use of harder metals for the engine machinery and for the rails—a significant fact—and Mr. Brewer, long since, has urged the necessity of getting more superheated steam into the cylinder at every stroke, and avoiding the old fallacy of keeping it out by means of short, wire-drawing cut-offs. Such facts must always be kept in view.

The quotations of P.L.M. compound working, from page 509, June 8th, 1917, include, as a matter of course, such economy as may be due to the use of superheated steam; consequently, Mr. Brewer is obviously under a misapprehension that "'R. C.' appears to be convinced that compounding cannot be improved by superheating." Convictions and personal opinions are negative values. The facts alone ought to stand, and, above all, those facts as autographed by the steam itself. These show that, at all speeds and at all economic cut-offs, the indicator card areas—*e.g.*, horse-powers and tractive efforts—are from 50 to 60 per cent. larger in compound than in single expansion, whether the steam is saturated or superheated. As this may, again, be construed to read that there is "no gain by superheating," I here quote "index" figures of steam consumptions in first-class modern superheater simple locomotives, and, in normal, balanced piston load, compound engines—by which qualification are ruled out all locomotives with double reversing gears, both French and Italian, and von Borries' or all other locomotives which are operated with long low-pressure cut-offs in such a way as to reduce the card areas and the fuel economy to, more or less, that common with single-expansion pure and simple.

	Steam per indicated horse-power per hour. Compound. lb.		Simple. lb.
Saturated steam	18·5	50 per cent. higher consumptions	= 27·7
Saving by superheated steam during tests (one-fourth)	— 4·7	Ditto	— 6·9
Superheated steam	= 13·8	Ditto	= 20·8

This will satisfy Mr. Brewer and others that 25 per cent. is duly shown as the test fuel economy by superheating in both simple and compound engines alike. The "20·8 lb." consumption quoted is net of water losses for footplate services and auxiliaries, as reckoned off in both the "Lima" 240 lb. pressure simple and the "Castle" 225 lb. simple in the Swindon–Plymouth dynamometer tests of March, 1924. These compound engine figures are about 2 lb. above some recorded in dynamometer tests elsewhere than on the P.L.M. In the recent revival—in large numbers—of the two-cylinder cross-compound with saturated steam for Austria and for Bulgaria, modern improvements have notably reduced consumptions below those usual for the latest superheated steam simples. The Italian two-cylinder compounds—Fig. 7, page 570, December 9th, 1904—are now highly prized in Italy. These facts have been so far ignored for lack of commercial interests behind the revival; but railway engineers cannot overlook the fact that the Reichsbahn Central Administration, always so notoriously opposed to double expansion, reported: "Results excellent" of the new Bulgarian saturated steam compounds; yet "Results nil," both of the trip valve gear engines and of the Stumpf simple uniflow locomotive. It should also not be forgotten that in his report on the workings of the innumerable systems of locomotive on the

French State Railways, Mr. Nadal, summarising on the Vauclain saturated steam compounds—Baldwin—showed that it was 26 per cent. more economical than the new Baldwin simples of 200 lb. pressure, and that their net indicated steam consumptions varied from 15·5 lb. to 18 lb. per indicated horse-power hour. The superheater company would further claim to reduce this rate by one-fourth (= 11·7 lb. to 13·5 lb. per indicated horse-power hour, as now actually realised in various compound engines).

Persons having a small acquaintance with English locomotives have urged that there must be a "snag" somewhere—that the compound engines may, indeed, pull 20 per cent. heavier loads and save 15 per cent. of the coal at the same time and cost less to upkeep, yet there must be something "wrong" in it since Messrs. Webb, Hughes, Ivatt, and numerous others all failed to get "results." In this implication the average man always harps back to notorious failures, and frankly refuses to learn of the recent advances. We are also told that "all the Continent is returning to single expansion," while precisely the reverse is the fact. With many hundreds of modern British, German and American simple superheater engines now working in France, the railways, as now amalgamated, are reintroducing compound engines throughout France and also in Italy. We now travel from Brest to Marseilles and to Brindisi by compound locomotives of a power unknown in this country, although we use even larger boilers. There is no "snag" there. The real trouble in this country has been the non-observance of quite elementary technical rules essential for success if a boiler now used for trains of up to 500 tons is to be made to haul 750 tons at express speeds without any increase on its present coal consumptions per trip. To earn increased dividends by compound expansion alone involves many "don'ts" to those designers who would avoid the blunders which led to the first ending of compound expansion in this country after Garbe began his Schmidt campaign here. It has been said that had Schmidt patented compound engines instead of superheaters, every railway in the world would now be using compound engines.

Sentiment for the Stephenson locomotive, after 100 years, is now out of place with the growing fierce competition against railways by the motor car and char-à-banc. In the *Spectator* we read a demand for "Pullmans" and the like, and higher speeds at lower fares, if railways expect further patronage. All that is possible with compound expansion—greater loads, higher speeds with lower all-round expenditures, and no patents to take off the full gain by the railway companies. But these results must be guaranteed to the companies, with penalties for failures. You cannot ask designing staffs, used all their lives to simple expansion, to make a success where their fathers had so repeatedly failed. No amateur attempts are again feasible. When we want a vertebrate hinged concrete railroad arch we call in specialists, who comply to general specifications. Compound locomotives require very high specialisation. Few are the orders that come to England for "waterless" or for compound locomotives. The time has now arrived, on the fiftieth anniversary of the compound locomotive, to initiate a new era in railway travel that will surprise and delight the passengers.

Some apology is due to readers for the statement of "percentages," as given on page 613: "20 to 30 per cent. to be taken off road figures to compare with bench test conditions." This should be 15 to 20 per cent. As regards the "Lima" locomotive, the total averages show that 22·92 lb. superheater steam per indicated horse-power hour is 20·16 lb. when deducting for accessories = 12 per cent. "Possibly 15 to 20 per cent. of the steam generated is used by the auxiliaries or is lost," writes Mr. Paul Clayton, on page 5, in Bulletin No. 65, University of Illinois Experiment Station, in referring to the conditions in road working as compared to those recorded on the Pennsylvania Railroad Altoona testing plant, wherein every loss other than that which actually occurs in the cylinder is always very carefully deducted, so that "spot" point figures—made at constant cut-off, pressure and speed—are obtained which have no parallel in road service, with the customary varying cut-offs, &c., but which have, nevertheless, entered into general Press descriptions of American locomotives as being average figures of actual working, and thus conveying abroad an idea of amazing economies that are never found in similar locomotives as imported by continental and colonial railways. Clayton, page 34, Michigan Central Railroad cross-compound "No. 585, average moist steam consumption per indicated horse-power hour was 19·9 lb. at same speeds as No. 929." (Tests, A.D. 1904, Louisiana Exposition, St. Louis, Missouri, U.S.A.)

The Boston and Albany Railroad has therefore performed a most important service in showing by a great number of road tests (1925) the actual consumptions of a "super-power Lima locomotive," with 50 per cent. limited maximum cut-off, over 8in. valve travel, 240 lb. boiler pressure, superheater, feed heater and other fuel-saving devices. Not less important has been Mr. Collett's (G.W.R.) contribution to the railway world in revealing the facts of road working by a high-pressure British locomotive (1924) on which previously the ideas entertained, here and abroad, had been of both fantastic and nebulous. To the *Great Western Magazine* statisticians abroad owe a great debt for the first complete indications concerning modern British engines of high repute in the "exchange tests," 1925, and using coal of a very high, known quality, so enabling valuable comparisons of work in ton-miles per hour per ton of steam.

December 5th. R. C.

SIR,—Your correspondent "Compound" is evidently one of those enthusiasts who regard compounding as the hall-mark of perfection so far as locomotives are concerned. His statement that our locomotive engineers must feel "uncomfortable" is really too funny for words. If he had a better understanding of the conditions which govern the designing of British locomotives he would not make such a statement.

Many of your old readers, including Mr. F. W. Brewer, will remember that about fifteen years ago I started a discussion on "British Locomotive Practice of To-day" in the columns of THE ENGINEER, when the vexed question of compounding was thoroughly thrashed out.

The fact of the matter is that when a really powerful locomotive is needed, say, for instance, an engine to equal the power output of one of Mr. Gresley's "Pacifics," compounding is ruled out of court for the simple reason that the English dimensional gauge does not permit of sufficiently large low-pressure cylinders.

To equal a Gresley "Pacific" the low-pressure cylinders would require to be 25in. diameter. These could not be fitted between the frames, and even if they were placed outside with the connecting-rods driving close to the wheels and the coupling rods in the extreme outside position, the cylinder covers would still project beyond the loading gauge.

It follows, therefore, that if compound engines of great power are to be used in this country much higher boiler pressures will have to be used in order to compensate for the restricted cylinder volumes.

Taking the matter in all its aspects, I still hold the view that the three-cylinder simple engine is the best proposition for an all-round economical locomotive where great power is required. Adequate bearing surfaces are also a good feature of the three-cylinder engine. CHAS. W. DAUNCEY.

Birmingham, December 8th.

CONGESTION AND REDISTRIBUTION OF POPULATION.

SIR,—The whole problem of migration within the British Empire is beset with difficulties and contradictions; in fact, in many ways the needs on the one hand and the restrictions and conditions on the other are such poles asunder that it would appear almost to pass the wit of man to reconcile them. We have in this small country an enormous and ever-increasing population, crammed into congested districts, literally "eating its head off" in these days of trade depression, unemployment and the dole. We have a dwindling agriculture, and a growing dependence on countries overseas for our food supplies and our markets. Against this, we have vast Dominions and Colonies unpeopled and undeveloped, possessing incalculable resources, awaiting only the necessary man power. Never before was there such urgent need for redistribution of population. "But," the Dominions say, "we want only your agriculturalists," and it is precisely these of whom we have so few, and can least afford to lose.

The Empire Community Settlement Committee puts forward a migration proposal on entirely original lines, and in the interests of those who are neither capitalists nor land workers. It is intended for those who have assured incomes or pensions ranging from about £250 to £800 a year, such as ex-officers and officials of H.M. Services, retired members of the professions and those having annuities or incomes from investments, all of whom are finding life increasingly difficult in this country, owing to the present stringent economic conditions. Many are still in the prime of mental and physical vigour, but can find no outlet for their energy in this country. Most of them have children to educate and equip, and the prospects for such children are not rosy in Great Britain in its present overcrowded state.

Briefly, the plan is to establish residential communities of from fifty to a hundred families, of kindred tastes and interests, in those parts of the Empire best suited for such settlement. South Africa, New Zealand, British Columbia, Australia and the West Indies appear to be especially favourable for the purpose. Each community settlement would hinge, as it were, on a central club house. Here all the catering would be done, and the social life generally of the community would be centred. In the surrounding gardens and grounds would be the separate furnished dwelling accommodation of the residents and facilities for outdoor recreations. There would also be a small plot of ground for each, for the practice of some form of small husbandry under skilled tuition. This would provide not only healthy occupation, but would be a means of adding to income. It would also give valuable experience to those thinking of taking up agriculture, &c., on a large scale.

Perhaps one of the best and most original features of the project is that the community settlement itself would not be for permanent residence. It is intended to be a temporary home to which families could move with ease from this country, and in which they could live comfortably within their incomes while they are testing life under new conditions and in a new country Thus would be removed one of the greatest deterrents to migration, viz., lack of knowledge and of the means to acquire that knowledge by personal experience.

Furthermore, the new arrival would not be faced with the immediate necessity of finding a house and domestic servants, while ignorant of local conditions and prices. For in the community settlement the catering and maintenance services would be all provided, and at a figure as low as would be compatible with ordinary comfort. Luxury would not be aimed at.

During this trying-out period, which has been provisionally fixed at a maximum of five years, the only financial obligation of the residents would be to guarantee their rent, club subscriptions, &c., the latter covering food and all services.

For those who, after the trial period, desire to settle down permanently, there would be land available in the vicinity on which a house could be built, on a system of time payment. Any so desiring could do this before the expiry of the five years in the community settlement, providing his place could be filled from the waiting list. This waiting list is essential, for the following reason. The E.C.S. Committee do not intend to have any financial interest in the project. They regard it as essential that they should be free from considerations other than the interests of the settlers. For the provision of the land, buildings and maintenance services needed for the settlements, the Committee considers that the Dominions, realising the value to themselves of such immigration, should be responsible. The Vice-chairman, Sir Roland Bourne, is at present in South Africa examining this question, and he reports that in both official and private circles the proposal is received with warm approval. Excellent offers have been received, and are being investigated by Sir Roland. There is thus good ground for believing that responsible interests in the selected Dominions will furnish the accommodation required, if they are satisfied that expenditure incurred thereby will be covered by a fair return. This return would be assured by the guaranteed rents and subscriptions of the residents; but as these would be assessed on the basis of a full settlement, it is necessary that there should be families ready to take the places of those desiring to change from leasehold to freehold.

It will be seen therefore that the Committee's project falls into three parts. First, to place Britain Overseas within the reach of those of limited resources; secondly, to provide for them a comfortable and inexpensive home, with congenial society, what time they "sense the country" and gain experience; and, finally, to enable them to establish themselves permanently in their new home with no resources other than their assured incomes. Too much stress cannot be laid on the importance of being enabled to test a country thoroughly before burning one's boats.

Although I have spoken principally of "grown-ups," it is perhaps their children who would benefit most. Educated, trained and acclimatised to the conditions overseas, they would be well fitted to develop a freer and fuller life, with greater chances of ultimate prosperity, than this country affords nowadays. And it must not be forgotten that it is upon the population and development of our Dominions and Colonies that the well-being of the British Commonwealth depends.

Such, at any rate, is the creed of the E.C.S. Committee, and they embodied their design in detail in their report, which may be had on application to the honorary secretary, 89, Kingsway, W.C. 2. Since its publication in April, it has been circulated by the principal Government Departments throughout H.M. Services, and through private channels to many to whom it might appeal. The response has shown that there is definite and urgent need of a migration plan on the lines suggested. Sir Roland Bourne returns to London in January, and it is hoped then to take vigorous measures to put the plans into effect. To make this possible, one thing alone is needed—definite and strong evidence of the desire for community settlements. Supply, as ever, will follow demand.

MURDOCH MACDONALD,
Representing Engineering and Industry,
Empire Community Settlement Committee.

December 8th

LOW-TEMPERATURE CARBONISATION.

SIR,—With reference to Mr. David Brownlie's letter in the current issue of your journal, regarding the promotion of an institution or association of fuel technology and low-temperature carbonisation, it may interest many of your readers to know that the Institution of Fuel Economy Engineers has already been formed and includes in its objects those suggested by your correspondent.

The main objects for which the Institution is established are: —(*a*) To promote the science and practice of fuel economy engineering in all its branches, and to give encouragement to the use of inventions and an impulse to methods likely to be useful to the members of the Institution. (*b*) To enable engineers and others interested in the preparation, use and combustion of fuel to meet and correspond, and to facilitate the interchange of ideas respecting improvements in the various branches of fuel technology, particularly in regard to the economical preparation and combustion of fuel for industrial purposes, and the publication and communication of information on such matters.

It is anticipated that the Council will shortly be in a position to appoint a special committee to deal with the important subject of low-temperature carbonisation, and it is hoped that this decision may be announced at an early date.

In the meantime, the undersigned will be pleased to forward full particulars of the Institution to any of your readers who may be interested in it.

H. L. PIRIE, Secretary.

29, Sherwin-road, Lenton, Nottingham,
December 7th.

THE FRENCH NAVAL RENAISSANCE.

MONSIEUR,—Nous avons relevé, en lisant l'article intitulé "The French Naval Renaissance," paru au n°. 3142 du 11 Octobre, 1925 (page 407 de THE ENGINEER), l'information suivante, relative aux Croiseurs de 8000 tonnes, construits pour la Marine Française:—"It is therefore not surprising to learn that the preliminary steam trials of the Duguay-Trouin have failed to give complete satisfaction."

Nous avons l'honneur de vous faire savoir que c'est notre Société qui a établi les plans des appareils-moteurs de ces bateaux, et, en cette qualité, nous vous informons que, contrairement à ce que vous avez publié dans le numéro précité de votre Revue, aucun essai de bateau de ce type n'a eu lieu jusqu'ici. En conséquence, nous espérons que vous voudrez bien rectifier dans un prochain numéro de votre journal l'information en question qui est erronée.

COMPAGNIE ELECTRO-MECANIQUE,
P. LAMBERT,
Paris, 27 Novembre. Le Secretaire General.

[We must express our apologies to the Compagnie Electro-Mecanique. Our information was that the basin trials of the Duguay-Trouin took place in September, but we were obviously misinformed.—ED. THE E.]

LOCOMOTIVE SUPERHEATING.

SIR,—The Great Western Railway was the first line in this country to put a superheater locomotive into service. The engine in question was No. 2901, a two-cylinder 4–6–0, and it was fitted with a Schmidt superheater in May, 1906. Two Lancashire and Yorkshire Railway 0–6–0's were, however, contemporaneous, these being Nos. 898 and 900, both of which were equipped with the Schmidt apparatus in 1906, No. 898 in November and No. 900 in December.

Like the Lancashire and Yorkshire, the Great Western deserves credit for being one of the pioneers of what may be termed modern locomotive superheating here, and for having very carefully investigated the matter.

F. W. BREWER.

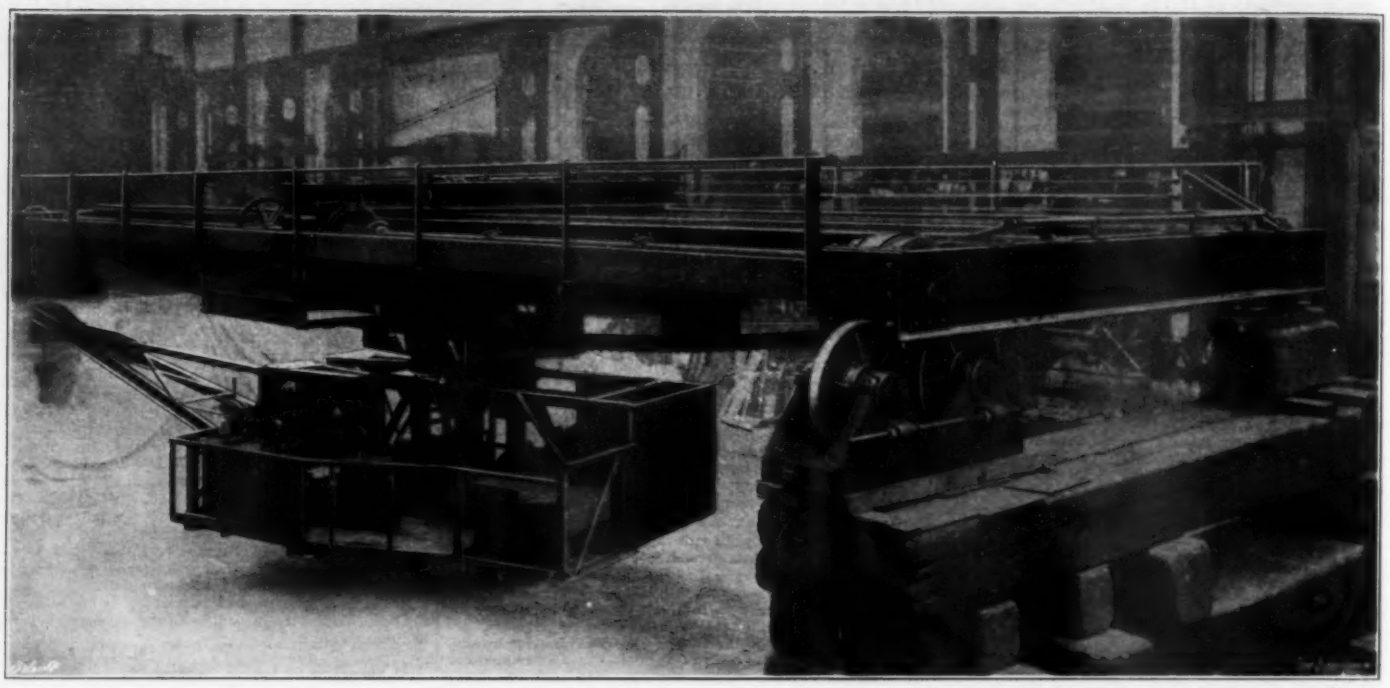
Stevenage, Herts., December 5th.

AN IMPROVED ACCUMULATOR.

AN accumulator, for which important advantages are claimed, has been brought to our notice by the Tungstone Accumulator Company, of 3, St. Bride's House, Salisbury-square, E.C. 4. A partly pasted plate, which has been sent to us, gives a good idea of the construction of the grid, which is composed of pure die cast lead units joined together in one operation on all four sides by liquid antimonial lead fed under pressure into recessed grooves on the outer edges of each unit; and at the same time a frame is formed round the complete plate. The paste is forced under pressure into both sides of the plate simultaneously, and through the entire depth of the interlacing holes in the grid, which is designed on the lattice basket principle. Notwithstanding that a very low percentage of antimonial lead is used in the construction of the grids, the plates are very robust. By the use of a large volume of pure lead the makers claim to obtain an appreciably increased capacity and a long active life for the accumulator. No wood or celluloid separators are used, and another special feature is the employment of a seamless indestructible metal container, designed to resist acid, heat, corrosion, &c. These antimonial lead containers are made by a patented high-pressure die casting process. The accumulators are made for motor car, wireless and other classes of service, both high and low-tension wireless accumulators being supplied.

UNDERHUNG TRAVELLING JIB CRANE FOR KILINDINI

THE VAUGHAN CRANE COMPANY, LTD., OPENSHAW, MANCHESTER, ENGINEERS



Underhung Travelling Jib Crane.

FOUR 1-ton, four-motor, overhead electric travelling cranes, with underhung revolving jibs, have recently been constructed by the Vaughan Crane Company, Ltd., Openshaw, Manchester, to the order of the Crown Agents for the Colonies, for Kilindini Harbour, on the Uganda Railway. One of the special features of these cranes, which are illustrated in the accompanying engravings, is the underhung revolving jib, which enables loads to be lifted out of an adjoining bay and deposited in the bay in which the crane operates.

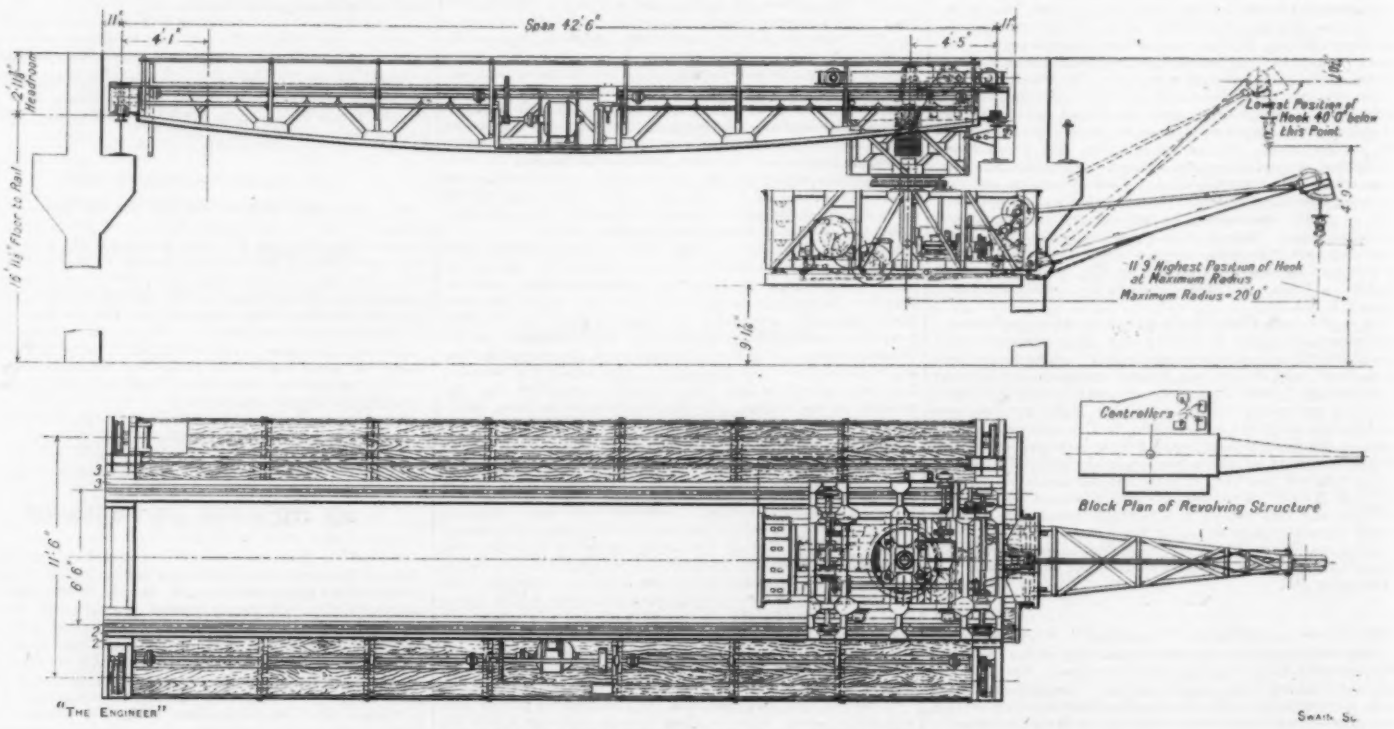
The chief dimensions of the cranes are :—Span, between rail centres, 42ft. 6in.; height, floor to gantry rail, 16ft. 11¼in.; and radius of jib, centre of post to centre of load, 20ft. maximum and 17ft. minimum. The crane is fitted with motions for hoisting, cross traverse and longitudinal travel, each operated by a separate electric motor and train of gearing, and there are also slewing and luffing motions operated by a single motor clutch and gearing. The following are the operating speeds :—Hoisting, 150ft. per minute; slewing, 125ft. per minute; luffing, 50ft. per minute; cross traverse, 100ft. per minute; and longitudinal travel, 200ft. per minute—all the motor speeds being 700 revolutions per minute.

The electrical equipment is designed for three-phase alternating current, 50 cycles at 415 volts, and all the motors are of the slip-ring induction reversing type, having high starting torques. The motor controllers are of the tramway type, and the metallic resistances are furnished with a number of contacts for the regulation of speed in either direction. The controllers are arranged in the driver's cage, which is carried on one side of the revolving underframe. The cross girders, which are of the lattice type, are built up of mild steel sections, and well strengthened with stiffeners. The end carriages are constructed of steel plates and angles and channels, the connection to the cross girders, to which they are bolted, being such that shearing stress on the bolts is avoided. Each end carriage is mounted on two large travelling wheels, which have double-flanged hard steel tires. These wheels are mounted on axles bushed with gun-metal. A platform extends the full length of the crane on each side.

The jib arm is built up of rolled steel sections and the traversing carriage, which is of steel sections, is arranged to accommodate the traversing axles, bearings, steel centre post and the traversing gear. The hoisting motion comprises a cast iron drum of large diameter, which is grooved to take the whole of the rope in one layer. It is driven from the 15 brake horse-power hoisting motor through machine-cut gearing, and the load is lifted on a single fall of steel wire rope, one end being fixed to the barrel and the other end being fitted with a lifting hook and balance weight. For slewing, worm and spur reducing gears are fitted, and they are operated by the same 5 brake horse-power motor which operates the luffing motion. The worm gearing operates in an oil bath, the worm being of steel and the worm wheel phosphor bronze. The luffing motion comprises bevel clutch gearing and worm, spur and crank and lever mechanism. The carriage is mounted on four cast steel double-flanged runners, driven from the 5 horse-power cross traverse motor through a train of machine-cut spur and bevel gear. The motor for the longitudinal travel motion is mounted near the middle of the span and drives one travelling wheel on each end carriage through the usual cross shaft and machine-cut spur and bevel gear wheels.

As these cranes will have to be operated by natives, every precaution has been taken in the design to prevent accidents, while the brakes are very powerful. Fitted to the hoisting motion there are a solenoid released brake and a foot brake, and there is a solenoid released brake for both the cross traverse and longitudinal travel motions. To prevent overwinding and overlowering there is an automatic circuit breaker, which instantaneously cuts off current from the motor. A feature of this device is that it is self-resetting after use, thus obviating the necessity for the crane driver having to mount to the crab to replace the switch. Limit switches are also fitted to the cross traverse motion.

The switch panel in the driver's cage has an equipment, comprising a triple-pole line contactor employed as a circuit breaker, two overload relays per motor, with time-lag device and one common return overload relay without time-lag device carried upon an extension of the panel. There is a red lamp to indicate overloading and a relay interconnected with the hoisting motor circuit. An auxiliary control panel contains a push button switch for resetting the line contactors, and a double-pole switch fuse for controlling the contactor operating the coil circuits.



ARRANGEMENT OF UNDERHUNG TRAVELLING JIB CRANE

Experiments on Strains in Boilers.*

By C. E. STROMEYER.

CORNERS of boilers are still counted amongst unsolved problems, partly perhaps because of the difficulty of measuring the local strains. My own attempts in this direction were made with mirrors, at Lea Bridge, but this method is very cumbersome. Subsequently, a very simple arrangement was devised, which gives reliable and permanent records.

In Fig. 1 C represents a section of a corner of a boiler, A B are the two points between which the bending strain is to be measured. Two scribing wires W_1 W_2, of about $^3/_{16}$in. diameter, are electrically dab-welded on to the A B spots. The ends of these scribing wires are provided with light sleeves p_1 p_2, in which gramophone pins are fixed crossways. The points of the pins are adjusted so as to be normal to the wires. A small piece of glass fixed in a suitable carriage, and slightly blackened by being held over a flame of burning camphor, is lightly passed under the pins, with the result that two traces appear on its surface. The desired test pressure is then applied to the boiler and another pair of lines scribed. Any bending of the corner results in a closing in or opening out of the traces. These records are fixed by allowing methylated spirits with a little shellac varnish to spread over the glass. The distances between the traces are then read off under a travelling microscope, and their difference

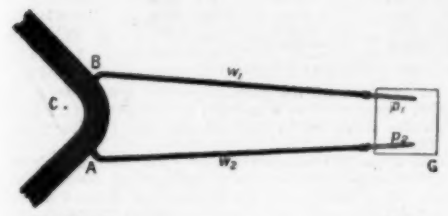


FIG. 1

divided by the distance A B and by the ratio of the lengths of the wires to half the thickness of the plate, and multiplied by the modulus of elasticity gives the average stress of the outer fibre between A and B. Slight corrections for curvature of the corner and for cross contraction—say, 10 per cent.—should be applied. The effects of average longitudinal stresses are negligible on short spans. Using scribing wires, 12in. long, spaced 1in. apart, readings which are correct to ±1 per cent. have been obtained. Probably much greater accuracy could be attained, for so far the difficulty has not been with the definition of the scratches, which were beautifully clear, but with the vernier readings of the micrometer. Using a more delicate measuring instrument, the records can be measured with greater accuracy than has been possible up to the present. Also, as the records are preserved they can be re-measured at any time.

The following measurements were carried out, and they demonstrate the use to which this device can be put, and throw light on the nature and intensity of bending strains, which up to now have not been measured. A special reason for entering on this very difficult study is that information from several sources is to the effect that English locomotive boilers are more prone to crack their corners than are continental ones. Probably their scantlings are lighter than ours.

RESULTS OF TESTS ON A SMALL LOCOMOTIVE PORTABLE BOILER.

Fig. 2 shows an elevation and a horizontal section, the positions of the pairs of wires being indicated by thick black lines. Readings were taken for successive pressures, but as slight permanent sets seem to have occurred in some parts of the structure, though not necessarily at the corners, only those results corresponding to a drop of pressure from 360 lb. to nothing are given in the following table. The following allowances and corrections have been made :—The modulus of elasticity has been increased from 30 to 33 million pounds per square inch to allow for the effect of cross contraction. The spans between the centres of the roots of the scribing wires were measured along the curved surfaces of the plates to which they are welded. Allowance has been made for the shifting of the neutral fibre of the plates due to the curvatures at the corners. These are given in the following table under corrected half thicknesses. The surface radius has been obtained by measurements from templets supplied by John Fowler and Co., Ltd., who very kindly gave all possible facilities for making these tests.

TABLE I.

Span	Plate thickness. In.	Span between scribing wires measured on surface In.	Surface radius. In.	Corrected half thickness. In.	Length of scribing wire. In.	Measured separation of scratches. Cm.	Estimated tension stresses at 360 lb. lb /sq.in.
A	1/2	1.03	.73	.178	10.30	−.036	11,760
B	1/2	.93	3.00	.195	9.38	+.016	10,120
C	1/2 (2)	.74	2.30	.477	9.38	+.044	33,400
D	1/2	.86	1.66	.192	9.25	−.030	9,400
E	1/2	.83	.80	.167	9.25	+.046	11,850
F	7/16	1.04	.74	.216	9.25	+.036	10,650

The estimated stresses are those due to bending. If, by calculation, average stresses are found in the plate, they should be added to these bending stresses. For instance, in this boiler the difference between the dimension of the outer case and the fire-box should create stresses of this nature; so should the screwed stays, but their combined effect is not easily calculated.

When calculations fail, it may occasionally be possible to measure the combined bending and average strain In such cases the average strain is found by deducting the bending strain, as found by scribing wires, from the combined strain as found by strain indicators of the usual type.

In my Memorandum for 1912 a detailed analysis of all published tests of stayed flat plates was made, which leads to the conclusion that a first permanent set takes place when the hydrostatic pressure reaches $667 \times t^3/D^2$ lb. per square inch. Here t is the thickness of the plate in sixteenths of an inch and D is the diameter of an inscribed circle which just touches the inner circumferences of the stays. In the present boiler t is $^6/_{16}$in. The stays were $\frac{3}{4}$in. diameter, pitched 4in. apart, therefore D = 4·79in., and the pressure at which permanent set should take place would be 1050 lb. per square inch. Assuming the elastic limit of the material to be 30,000 lb., the stresses in the stayed part of the plates would at 370 be about 10,500 lb. This is somewhat less than the estimated corner stresses in the table, particularly when the direct stresses are added, which means that the corners of locomotive fire-boxes and their casings are somewhat weaker than their flat plates. This result is in harmony with the experience that cracks in these corners are fairly frequent.

It is difficult to visualise the remedy which should be adopted. The edge stays might be placed further away from the corners than at present, and the corners might be more rounded. The plates might be made thicker or thinner. Increased thickness would, of course, give increased strength to the flat plates, but because it would increase the general rigidity, and because the corner stresses are due rather to rigidity of other parts than to weakness, it is quite possible that a thickening of the corners might increase the local bending stresses, or, at any rate, decrease them at a lesser rate than those of the flat plates. The severe stresses at the doubled corner U suggest that stresses would be reduced by thinning the

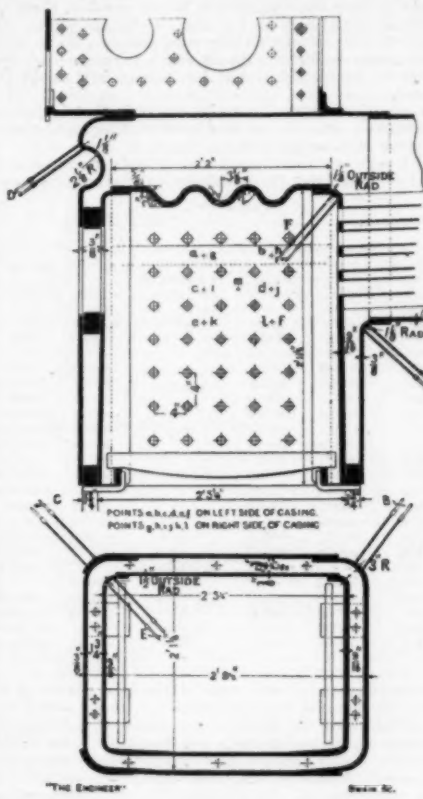


FIG. 2

plates; but then, of course, the wasting would grow in importance.

The following additional tests were made. A frame was placed round the centre of the fire-box casing, and the bulgings of its sides measured. They amounted to 0·0335in. on either side. In addition, the outer surfaces were trammelled, and it was found that on a span of 16in. between the outside rows of stays the acquired camber amounted to only 0.002in. The difference of 0.0315in. represents the outward movement of the outer rows of stays, and as these would carry the fire-box plate with them the fire-box corner should have opened out. The scribing wire measurements show that it bent in.

A much more detailed test than the one carried out would be required to settle the outstanding points, and such detailed tests cannot be carried out when, as in this case, advantage has to be taken of an official test to attach some instruments, which, few as they were, nevertheless must have interfered with the general testing arrangements. John Fowler and Co. (Leeds), Ltd., Leeds, very kindly permitted the tests to be made and also had the necessary wires welded to the plates.

While these pages were in the press, John Fowler and Co., Leeds, kindly invited me to witness another test of a fire-box of a similar design to the one shown in Fig. 2, but the corrugated crown was slightly altered. The hydraulic test and careful micrometric gaugings revealed no permanent set up to 550 lb. per square inch. Just as 600 lb. was reached some shell seams started to leak heavily, but the pressure could be maintained while readings were being taken, and, on releasing the pressure, slight permanent sets of the corrugations were discovered. They were of the order of $^1/_{16}$in. in a span of 18in. Evidently, the elastic limit had just been reached. Information as to the tenacity and the yield point of the material has not yet come to hand, but it will probably be of the order of 15 tons, or, say, 34,000 lb. per square inch. An estimate of the stress under which the corrugations gave way can be made by assuming them to be beams having a depth of 2¼in. at the centre, due allowance being made for the corrugated section, and assuming also that these girders are freely supported at their ends. The stiffening due to the vertical side plates is not likely to exceed 5 per cent., and has here been neglected. The estimated bending stress in these corrugated beams, under a pressure of 600 lb., works out at 43,000 lb. per square inch, or 26 per cent. in excess of the probable elastic limit. This is a very satisfactory result, for it shows that corrugated beams, like beams of other sections, offer greater resistances than those estimated from tensile tests. This result deserves to be widely known.

DONKEY BOILER DISHED CROWN PLATE.

Somewhat similar experiments to the above were carried out on a donkey boiler at Clayton, Son and Co., Ltd., Moor End Works, Leeds, to whom I also wish to offer my

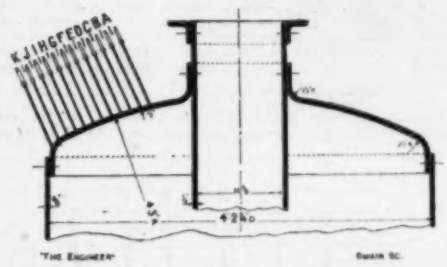


FIG. 3

best thanks. A series of twelve scribing wires was welded to the top dished end—see Fig. 3.

The dimensions of the boiler are :—

Diameter of shell	4ft. 3in.
Length of shell plate	8ft. 6in. approx.
Thickness of shell plate	⅜in.
Fire-box diameter	3ft. 6in. mean approx.
Fire-box heights	5ft. 1½in.
Fire-box plate thickness	$^{13}/_{32}$in.
Number of cross tubes	4
Fire-box crown plate	$^9/_{16}$in. thick 3ft. 6in. radius
Boiler top end plate	½in. thick 4ft. 3in. radius
Diameter of uptake	11¾in. internal
Thickness of uptake	½in.
Radius of curvature at root of flanges	2½in. and 1½in.

The lengths of the scribing wires were about 10½in. It had been intended to use only one long smoked glass plate for each reading, but it was found difficult to carry out this plan, and therefore the eleven traces had to be taken separately. This was done before starting and again when the hydraulic pressure had reached 200 lb., and after it had been released. There was no permanent set, and the results in the following diagram—Fig. 4—are based on the mean of the up and down reading.

In dished ends without an uptake acting as a stay, the negative stresses at K would be very severe, and would

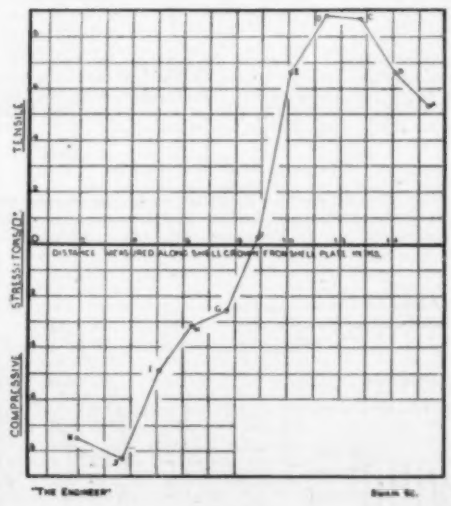


FIG. 4

rapidly change to tension stresses, say, at I or H. Looking on the uptake as being a stay which draws the dished end down, a spreading out of the tension stresses towards the circumference might be expected. But the reverse action has taken place, which suggests that the uptake acted like a strut. This is likely to have been the case for, due to cross expansion of the shell and cross contraction of the fire-box, the uptake would exert a thrust on the top dished end plate. This tendency would be increased under working conditions, and particularly when, due to incrustation, the fire-box might become overheated.

The following are a few of the estimated stresses in other parts of the boiler :—

Between rivets of shell plate = 9700 lb. per square inch.

Compression stress in furnace at 200 lb. per square inch = 8960 lb. per square inch.

LAP JOINT BENDING.

With a view to studying the behaviour of lap joints, the following experiment was made on a double lap joint —a single lap joint was not available—of a vertical boiler, 3ft. 6in. diameter and ⅜in. plates, to which scribing wires

* Manchester Steam Users' Association. Memorandum, 1924.

were welded—see Fig. 5. The readings were very consistent, but the results unsatisfactory, and suggest that secondary strains were interfering with the primary ones. Over a span of about 5½in. the average decreases of convexity expressed in angular measure were as per Table II.:

TABLE II.

Pressures ..	0–75	.. 0–100	.. 0–150	.. 0–200
Angle ..	0·00142	.. 0·000335	.. 0·000258	.. 0·000091

During this test there was much hammering on adjoining boilers which may have produced some effect.

The readings for the D and E spans are therefore given in Table III.:—

TABLE III

Pressure, lb.	0–75	75–100	100–150	150–200	200–0
Readings—					
Span D, cm. ..	−·008	−·005	+·006	+·014	−·019
Span E, cm. ..	—	−·018	+·014	+·022	−·063
Surface stresses—					
D, lb.	−1610	−1006	+1207	+2820	−3830
E, lb.	—	−3620	+2820	+4430	−12680

It will be seen that until the pressure 100 lb. was reached the bending was in a contrary sense to what might

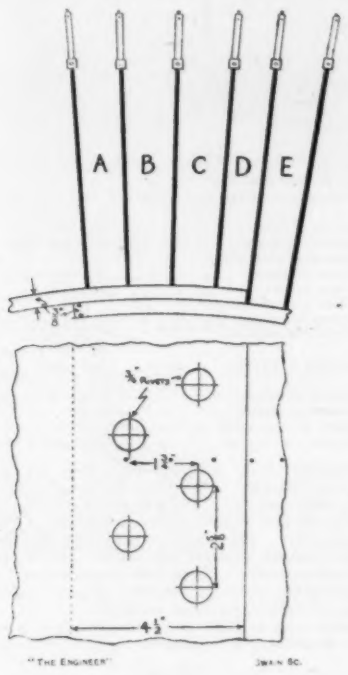


FIG. 5

be expected. On releasing the pressure the movements were all in the right direction, but they exceeded the sums of the earlier movements. This suggests that the limit of elasticity had been exceeded in some part of the boiler during the testing, though not at the seam.

STRESSES NEAR LAP JOINTS.

The following comparative tests were made during the test of the Pilkington boiler—see Memorandum, 1923, for dimensions. In the measuring instrument used the interference of monochromatic yellow sodium light, reflected from two surfaces, is made use of. The shifting of the interference bands through one pitch corresponded to a stress of about 30 lb. per square inch. The instrument was so placed that it measured the circumferential strains close to a lap joint; first, in the solid plate which covered the end of a lap seam, and, secondly, in the solid plate which was covered by the end of the lap seams. The bending of the solid plate, due to the irregular shape and the elasticity of the lap, would be in an opposite sense and would combine with the average shell tensions.

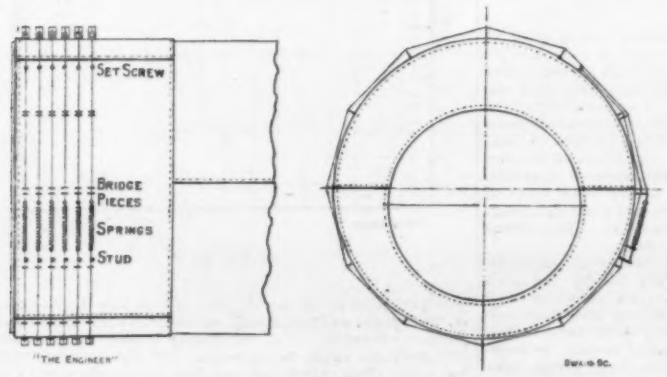


FIG. 6

In the first case the interference bands hardly moved, say, one band for about 25 lb. pressure. In the second case, sixteen bands passed the datum point for a change of pressure of 25 lb. Thus the bending and tension stresses in the solid plate near the lap were about sixteen times greater with the lap covering the plate than with the plate covering the lap.

SHELL EXTENSION EXPERIMENTS.

During the Lea Bridge tests an attempt was made to measure the circumferential extension of the shell plates.

The general arrangement of these experiments will be seen from Fig. 6. A series of set-screws was screwed into the one side of the shell plates, and a wire was secured to each, and wound round the circumference of the boiler. It was carried clear of its surface by means of a number of small rocking frames. The end of each wire was secured to a helical spring whose end was held by a stud. Small ivory scales and verniers—not shown—were attached to the wires at a convenient point below *a*, *b*, *c*, &c. An expansion of the shell would hardly alter the length of the wire. Its helical spring would stretch, the scale and vernier would slide past each other and their movement could be read off direct. No levers or other magnifying arrangements were employed, so that the results ought to be absolutely reliable. After the fixing of one of the wires, it was strained by pulling its helical spring a definite amount, and the stretching of the wire was read off on the vernier. This correction was small and has been taken account of.

The cross contraction due to the longitudinal tension is small, but a comparison of the March and August tests, when the furnace ends were closed, shows the reducing influence of the extra pull, about 8 per cent.—see Table IV.

A large number of readings were taken, and when the stresses were estimated they were found to be 50 to nearly 100 per cent. in excess of the stresses as estimated by the customary formula $S = p \cdot D/2.t$.

This discrepancy was not discovered until after the completion of all the tests. A possible explanation was the placing of the rocking frames for the circumferential wires. In order to keep their number as low as possible, three of them were placed high on the edges of the lap joints. If these joints have tilted with increasing pressure, the rocking frames would be lifted and an extra movement of the verniers of about 1.5 times the average lift would be recorded.

The practical conclusion to be drawn is that in future experiments a much larger number of rocking frames than the twelve of these experiments should be used.

The results of these several sets of tests are contained in the following Table IV., which gives the average circumferential extension of the shell at nineteen points of its length. It contains the elongations as measured with the help of the verniers. Then follow the average tiltings of the three lap joints of each belt (multiplied by 1·55). The next columns contain the circumferential elongations of the several shell belts, less the lap joint tilting corrections.

TABLE IV.

Position from each front seam.	Shell extension in inches as measured, Per 1 lb. pressure.		Correction for tilting of lap joints (1·55 × average tilt).	Corrected values of shell extension, per 1lb. pressure.	
	March, 1922.	August, 1922.		March, 1922.	August, 1922.
a. 0in.	·00019	·00021		·00015	·00017
b. 2in.	·00009	·00008		·00007	·00006
c. 4in.	·00018	·00019		·00014	·00015
d. 6in.	·00044	·00044		·00036	·00036
e. 8in.	·00065	·00054	·00017	·00053	·00042
f. 10in.	·00079	·00072		·00064	·00057
g. 18in.	·00091	·00087		·00074	·00070
h. 30in.	·00060	·00066		·00049	·00055
j. 0in.	·00064	·00055		·00052	·00043
k. 6in.	·00062	·00060		·00022	·00020
2. 18in.	·00039	—	·00026	·00013	—
3. 18in.	·00087	·00080	·00039	·00049	·00041
4. 18in.	·00076	·00082	·00043	·00032	·00039
5. 10½in.	—	·00082	·00039	—	·00042
6. 18in.	·00069	—	·00050	·00019	—
7. 25½in.	·00068	·00063	·00039	·00029	·00024
8. 18in.	·00068	·00055	·00031	·00037	·00024
9. 18in.	·00060	·00063	·00019	·00041	·00044
10. 18in.	·00061	·00063	·00019	·00042	·00044

The measurements *a* to *j* were not taken at the centres of the belts; they have in the last two columns been corrected in the same proportion as *g* in the centre plane. A similar modified correction has been applied to *k* on the second belt. It should be noted that the March measurements are with the furnace in place with open ends. After the collapse of the furnace its ends were closed, but it still acted as a stay, though not subjected to cross elongation.

The extensions given in the above table are for a decrease in pressure of 1 lb. per square inch. The circumferential extension, as calculated on the assumption that the boiler is a uniform cylindrical shell, is ·00049.

During increasing pressures there were numerous slippings of the lap seams, as revealed by leakages. During the August tests the lap seams were covered on the inside by white lead and strips of waterproof sheeting, but even this precaution failed when the seams began to gape.

SUMMARY OF TABLE IV.

Belts.. ..	1 (*g*) 10	2	9	3	8	4	7	5	6
March ..	·074	·042	·013	·041	·049	·037	·032	·029	—	·019
Means ..	?		?		·043		·0305		?	
August ..	·070	·044	—	·044	·041	·034	·039	·024	·042	—
Means ..	?		?		?		·0315		?	
Mean at March-Aug.	·072	·043	—	·0425	·045	?	·0355	·0265	—	—

It will be seen that the front end plate has a marked effect in barralling, at least on the first belt. The readings for *h*, *j*, *k* show that the double thicknesses of the circumferential laps produce a similar effect. The results of the centre readings of the belts ought to be symmetrically distributed over the length of the boiler. No. 2 and No. 6 are out of harmony and reduce the reliability of the results, but they should prove of interest.

The high values for *g* at the centre of belt 1 may be due either to the presence of a blow-off hole at the centre of this belt, or to a rocking bridge having been placed over this hole. Neither 5 nor 7 wires were in the centres of their respective belts, on account of a manhole in the one case and a stand-pipe in the other. Their results should be increased.

The above experiments had been preceded by similar ones at Messrs. Pilkington Brothers' works on a short-return tubular boiler. The circumferential wires had been stretched by means of weights instead of springs, and much trouble was experienced when these weights were accidentally touched. Then the carefully built-up series of rocking frames would all collapse. No measurements of the tiltings of the lap joints were taken; errors due to this cause could not therefore be corrected, but these errors seem to have been small, for the readings are what might be expected. The results of these tests are summarised in the following table:—

TABLE V.

Position from each front seam.	Mean circ. extension in inches per 1 lb. increase in pressure.	Position from each front seam.	Mean circ. extension in inches per 1 lb. increase in pressure.
(1) 0in.	·00018	(5) 1½in.	·00118
(2) 9½in.	·00084	(6) 26½in.	·00074
(3) 1in.	·00061	(7) 16in.	·00137
(4) 14½in.	·00077		

An estimate of the circumferential extension of the boiler, regarding it as a uniform cylindrical shell, leads to the value ·00076in. for the extension per 1 lb. increase in pressure.

Nos. 5 and 6 were respectively 1½in. from the circumferential seams on either side of the manhole strengthening ring; No. 7 was close to the dome; Nos. 3 and 4 were on either side of a patch, covering the opening for the junction valve block; and No. 2 was over a patch covering the opening for the blow-off block. No. 4 is the only measurement for the centre of a belt, and agrees with the above measurement.

Tests of Riveted Joints.

THE *Bulletin* of the University of Wisconsin, Vol. IX., No. 5, contains a paper entitled "Comparative Tests of Button Head and Countersunk Riveted Joints," by J. B. Kommers, Associate Professor of Mechanics, the University of Wisconsin Engineering Experiment Station. The tests carried out by the author have led him to the following conclusions:—

(1) The average ultimate shearing strength of the countersunk joints was at least equal to that of the button head joints for lap, single-covered butt, and double-covered butt joints.

(2) For lap joints the diameter of the rivet and the thickness of the plate seemed to have little effect on the ultimate shearing strength of the rivets.

(3) The bearing stress in some of the lap joints was 1.8 times as great, and in some of the double-covered butt joints 2.6 times as great as the ultimate unit shearing stress of the rivets.

(4) The slip at working loads was from 3 to 6 times as great for joints with rivets countersunk at one head, and from 5 to 8 times as great for joints with rivets countersunk at both heads, as for those with button head rivets.

(5) The deformation at working loads was from 1.7 to 2 times as great for joints with rivets countersunk at one head, and from 2 to 4 times as great for joints with rivets countersunk at both heads, as that for joints with button head rivets.

(6) The ratio of slip to deformation at working loads varied from 28 per cent. to 57 per cent. for joints with countersunk rivets, and from 15 per cent. to 23 per cent. for joints with button head rivets.

(7) The elastic deformation at working loads for joints with countersunk rivets varied from 35 per cent. less to 180 per cent. more than that for joints with button head rivets.

(8) The slip plus permanent set at loads near the ultimate varied from 45 per cent. less to 50 per cent. more for joints with countersunk rivets than that for joints with button head rivets.

(9) The deformation at loads near the ultimate varied from 33 per cent. less to 50 per cent. more for joints with countersunk rivets than that for joints with button head rivets.

(10) The ratio of slip plus permanent set to deformation, for loads near the ultimate, was practically the same for all types of riveted joints and averaged about 74 per cent.

From the results of the bending tests of the riveted joints the following conclusions are drawn:—

(1) The deflection at working loads was from 10 per cent. to 80 per cent. more for joints with countersunk rivets than that for joints with button head rivets.

(2) The deflection at loads near the ultimate varied from 20 per cent. less to 40 per cent. more for joints with countersunk rivets than that for joints with button head rivets.

From the results of all the tests, including tension and bending, the following general conclusions are drawn:—

(1) For riveted joints in which strength is the primary consideration, either button head or countersunk rivets may be used.

(2) For riveted joints in which great rigidity is desired, button head rivets should be used rather than countersunk.

(3) Because joints with countersunk rivets showed high strength and very considerable deformation, the indication is that for joints which may be subjected to impact or collision, and in which a high capacity for the absorption of energy is desirable, countersunk rivets should be used rather than button head.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

A Quiet Period.

THE last month of the year is generally a quiet one in the iron and steel industries of the Midlands. Little new business is given out, and what orders there are are for small tonnages to satisfy immediate requirements. The iron market in Birmingham to-day—Thursday—was only moderately attended, and few transactions of any magnitude were negotiated. It was noticeable that in the steel department an effort was made to stop the slump in values and that it met with some measure of success. The pig iron position is unchanged, while the reduction of 10s. per ton in Staffordshire best bar iron failed to produce any material increase in demand. On the whole the situation is not so bad as it might be, and both producers and consumers are confidently expecting better business in the New Year. Many of the Midland industries are now more fully employed, and have fair order books, and local iron and steel mills hope to supply a fair proportion of their needs, though they fully recognise the pull the foreigner has with his extremely low prices.

Staffordshire Bar Iron.

The reduction of 10s. per ton in Staffordshire marked bars, bringing the basis to £14, has done nothing so far to improve demand, and mills are only partially employed. This reduction of 10s. is the second this year, a fall of a similar amount having taken place in June last. It is recognised that this further adjustment had as its object the tempting of consumers, for it must have involved further sacrifice to the makers, whose production costs of late have tended to increase. No alteration has been made in the standard price of Crown and nut and bolt quality bars. They have, of course, fallen out of proportion to the readjstments made in prices of best bars. The Association figures of £12 and £11 respectively exist in name only. Lancashire mills offer supplies in this district at 10s. per ton below these prices, and Staffordshire mills have to cut their price to this level if they are to secure business. Both Association and non-federated houses now express their willingness to accept £11 10s. and £10 10s. for Crown and nut and bolt and fencing irons respectively, though the former still quote the Association figure. It was stated that a Nottingham firm has offered supplies of Crown bars delivered to purchaser's station at £11 7s. 6d., but this is not confirmed. Nut and bolt works in the Darlaston district are a little better employed, and are giving out small orders for common bars to Staffordshire mills, being unable in some cases to get delivery of continental material ordered some time ago. Attempts to end the strike in the Charleroi district having failed, local mills are looking for more of these accommodation orders. Belgian quotations have stiffened a little this week, and this is a further factor in favour of the local producer. Inquiries, pending contracts and work now in the hands of contractors, encourage the hope of important and improved business in the New Year. Mills in this area re-rolling steel remain well employed. They continue to share the business with the steel works.

Pig Iron.

The pig iron situation shows no change on the week. Orders are mostly for small tonnages for immediate consumption. There does not appear to be much addition to the forward contracts already given out for the New Year, both producer and consumer moving with caution. The recent improvement in demand and price is maintained, but has not been further strengthened. Stocks are much lower than recently, and there is no appreciable addition to output. Consumers are not perturbed, however, even when they are reminded that furnace coke values are stiffening. Derbyshire smelters this week refused to go below £3 5s. for foundry iron and £3 1s. for forge. Most of them wanted 1s. per ton above this figure. Northamptonshire makers quoted foundry £3 2s. 6d. and forge £2 16s. at furnaces. East Coast hematite was on offer at £3 14s. at furnaces for mixed numbers. Very little further progress is anticipated in the pig iron industry before the New Year.

Steel.

There has been a move in the steel department to put values on a firmer footing, and to some small extent it has been effective. In the absence of cohesion among producers, it could hardly have been expected that prices would have set firm. This week, however, there has been less "cutting" of rates, and in no instance do they appear to have sunk below last week's rates. Values having fallen week by week for some time, this steadying of the market cannot but be viewed with satisfaction by producers. Small bar quotations have been raised to £8, but business can be done at £7 17s. 6d. Even this figure, however, is half-a-crown better than last week's minimum. There were fewer firms willing to dispose of angles and joists at £7, and the ruling basis of transactions is now £7 2s. 6d. Tees sell at £8 2s. 6d. Ship, bridge and tank plates are obtainable at half-a-crown to 5s. per ton below the official quotation of £8, and the same applies to boiler plates, the demand for which is very slack at the moment. Mild steel billets sell slowly at £6 to £6 2s. 6d. Inquiries for most classes of steel are numerous, though many are considered to have as their chief object the sounding of market depths. Those transactions which have taken place in constructional material of late have run to heavier tonnages than has been customary in recent months. Foreign competition continues a serious factor in the situation. Continental quotations have firmed up a little, and some merchants this week want £5 7s. per ton for Belgian soft billets. This is a rise of from 1s. to 2s. per ton on last week's figures. Untested joists are still offered at £4 17s. Antwerp, and universal plates at £5 15s. Many Birmingham merchants are taking advantage of these materials for shipment to foreign ports. Midland railway carriage and wagon building firms are well occupied and take moderate quantities of steel, but less wrought iron. Constructional engineers are busy tendering for new work, especially for railway renewal and building extensions, the reconstruction of stations, &c. They are calling for increased tonnages of material.

Steel Scrap.

Steel scrap remains a firm market, largely on account of the steadily reducing imports of this material. The recognised price of £3 7s. 6d. delivered South Wales, or £3 17s. 6d. delivered Birmingham, is readily paid. As there are no large stocks of this material and demand is on the increase, it is thought that an upward movement of prices is probable in the near future.

Galvanised Sheets.

The galvanised sheet trade continues in a strong position on the basis of £16 12s. 6d. per ton for 24 gauge corrugated sheets. Occasional bookings this week have been at £16 15s. The new business is practically all for next year's delivery and the mills are assured of regular employment for some months to come. Both home and export demand is maintained. Black sheets are in moderately good request, and values are firm.

Ironworkers' Wages Reduced.

Wages of ironworkers in the Midlands which are regulated by a sliding scale under the Midland Iron and Steel Wages Board were reduced on Monday last 2½ per cent. This follows two other reductions of a like amount, and brings puddlers' wages down to 57½ per cent. above the basis rate of 13s. 6d. Though the bi-monthly ascertainment showed a substantial improvement in demand during September and October, selling prices declined.

Bank Rate.

The hope which had been held in Midland industrial circles that the bank rate would remain at 4 per cent. for the remainder of the year has been shattered, and the increase to 5 per cent. is unfavourably commented upon. Manufacturers and traders generally recognise the necessity for protecting gold reserves, but cannot be expected to welcome anything in the nature of further obstacles to trade improvement and business expansion.

Unemployment.

A decrease of 1176 in the number of unemployed in the Midlands on the week has brought the total to 120,927, of which 90,329 are men, 1465 boys, 26,654 women and 2479 girls. A fall of 5000 in the registered unemployed in a fortnight is a healthy sign. No doubt many have been only temporarily taken off the labour exchange books on account of the special Christmas rush, especially in the distributive channels, but there are others who have found permanent berths.

Derbyshire Miners' Strike.

The miners at the six pits of the Blackwell Colliery Company, Derbyshire, withdrew their labour on Monday as a sequel to a lightning strike of men at Bewinning Colliery in sympathy with a number of men dismissed on the ground that they had repeatedly filled an excessive quantity of slack with the coal sent out. The men had previously balloted as to the advisability of a strike.

Visit to the G.E.C. Witton Works.

The members of the Coke Oven Managers' Association, while in Birmingham in connection with their annual meeting, paid a visit to the General Electric Company's Witton Works, on Friday, the 27th ult., and the Magnet Club, which the firm has presented for the benefit of its employees, was placed at their disposal for the day. In the morning a lecture was given in the lecture room by a member of the Association, Mr. E. C. Evans, on "Fuel Problems from the Point of View of Iron and Steel Industries," and after the lecture the visitors were entertained to luncheon, the gathering being presided over by Dr. A. H. Railing, the director of the General Electric Company's Witton Works. After luncheon the visitors made a tour of the works, char-à-bancs being provided to convey them between the more distant points. When the inspection was completed an adjournment was made to the club for tea, during which several films, illustrating the coke-handling and screening plant manufactured by the Fraser and Chalmers Engineering Works, of the General Electric Company, were exhibited.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THERE is general dulness in the iron and metal markets this week, and the deadening effect of the holiday and stocktaking period at the end of the year seems to be felt here earlier than usual. Probably this is partly the result of the active buying, at any rate in the foundry iron trade, which occurred in October and November; but there appears to be a good deal of doubt regarding those optimistic opinions about the New Year revival of trade which were prevalent a short time ago. Hence there is not now much disposition to negotiate for forward business, although manufacturers and selling agents still profess to believe that all prices will be on a higher level next year. The raising of the Bank rate by 1 per cent. has had rather a depressing influence here on trade, for it was very generally assumed up to last week that cheap money would be one of the influences which would encourage the revival in the spring.

Metals.

Whether dearer money has much to do with the further decline in copper prices may perhaps be doubted. The copper market is in a peculiar position; prices are unquestionably low, but at the moment the production seems increasing in spite of the low prices, and although consumption is still good in the United States, it is only very moderate in Europe. One of the chief European consumers, viz., Germany, does not seem able to get over the financial difficulty. The figures recently published show an increase in the October "world production" of about 13,000 tons, and although this is not very much, it comes at a time when the market would have preferred to see a decrease. It cannot be denied that the political situation in Europe now that the Locarno Treaties have been signed is better than it has been for a long time, and this improvement ought to tell on trade later; but so far it has had little effect. The total engineering demand for copper is perhaps a little larger than it was, but it grows very slowly in this country, and one cannot help thinking that the relatively high prices for manufactured copper and brass are a hindrance to development. With refined copper at £64 and spelter at £38 it is very difficult to see why locomotive brass tubes should be charged at 1s. per lb. (£112 per ton) or copper tubes at 1s. 1¼d. (£123 13s. 4d. per ton). It is clear that engineers must be hampered in their competition for new business by these excessive costs for material. They can have cheap British steel now and fairly cheap British castings, but they must pay "through the nose" for copper sheets and copper and brass tubes. Prices for non-ferrous scrap metals are fairly easy this week. Mixed gun-metal scrap can be bought at low prices, for dealers here are paying only about £48 per ton for it. For yellow brass scrap of heavy quality they pay proportionately a good deal more, viz., about £43 per ton; but this scrap is cheaper than ingot brass. In the market for tin there have been the usual irregularities, but the average price keeps up fairly well, and in Manchester the opinion still holds that £300 per ton will eventually be reached. Lead is in a very uncertain condition, and the belief here is that prices have yet to come down. We have not yet felt the effect of the larger shipments from Australia. Spelter has been fairly steady, and a fair amount of confidence is felt in that market.

Pig Iron.

The market here for foundry iron is quiet and rather dull. Only a small and intermittent business is being done, and the falling off in demand at the approach of the end of the year is rather earlier than usual. One cannot say that there is much weakness yet amongst sellers, and probably those merchant firms which were bearing the market up to last October do not now see their way to continue operations which had been profitable up to the end of September. Of course, there is no room now for any continuous fall in prices, such as brought down prices by fully 15s. in the first nine months of 1925. Such a fall, in present circumstances, would mean the wholesale blowing out of furnaces. On the other hand, a return to the early prices of 1925 would undoubtedly cause the restarting of a good many idle furnaces. The chances seem therefore to be in favour of steady prices in the pig iron market for some time to come, and this is perhaps one reason why consumers are not anxious to buy far into the New Year. In Manchester the nominal price for No. 3 Derbyshire foundry iron is 73s. 6d. per ton delivered; but the market is not so firm at 73s. 6d. as it was a fortnight ago. Business has been done at 73s., and some merchants say that they can buy at 72s. 6d., or equal to 65s. on trucks. Such a price may be taken occasionally, but it is certainly not usual. One notices that the Northamptonshire furnaces are now asking 1s. more per ton, and although this does not affect Lancashire, it tends to lessen the competition in the Midlands with the Derbyshire brands. The demand here for Scotch foundry iron remains poor and the price for delivery in Manchester is about 94s. per ton. East Coast hematite can be bought here at 6s. less than Scotch No. 3.

Steel.

Business in manufactured steel is not quite so slack as it was in the worst times recently, but the larger volume of business is obtained by means of very low prices. Nominally, steel plates are at £8 per ton in Manchester, but it is well known that £7 10s. has been taken, and there are continental plates to be had at more than £1 per ton less for delivery in the Manchester docks. There was a nominal reduction in the "official" North-Eastern prices for sections of 2s. 6d. per ton, but it makes no difference to the actual selling prices here.

Scrap.

The market for scrap materials is dull and quiet, but there is no definite alteration in the general position. For steel scrap it is said that the demand is slightly better, and certainly the dealers here are willing to buy for delivery in trucks at 52s. 6d. per ton, and this shows that they must expect at least 62s. 6d. in Sheffield. The Welsh market is at about 65s., but Welsh trade with Lancashire must wait until the railway companies think it worth while to try for the traffic. Under the old rate scrap steel might still go to Wales from this district.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade in the North-West district is still improving. True, the movement is slow, but it is all the better for that, for past experience has proved that sudden improvements are followed by sudden slumps. Both from Scotland, the Midlands and South and North Wales there is coming a bigger demand for iron, and the two former districts are now becoming good customers—better, in fact, than for nearly twelve months. There is a tendency to place more forward orders and most of the works now carry contracts which, if they increase much, will mean more furnaces going in. At Ulverston the North Lonsdale Ironworks have put in their two furnaces, their stocks having been cleared. There is talk of more furnaces going in in Cumberland, but there is nothing definite yet. The steel works at both Barrow and Workington are taking a good quantity of iron, and that is helping to clear the present output. There is no occasion to speak of stocks now, for they do not amount to much. The continental

trade in ordinary mixed numbers is not big, but inquiries for special qualities are increasing. Trade with America continues, and a cargo left Barrow for Philadelphia last week.

Iron Ore.

There is a better outlook altogether for the iron ore trade, for not only is the local demand increasing, but there are more inquiries for outside delivery. It is very satisfactory to have to report that the important mines at Hodbarrow, which have been idle for some time, have restarted this week, which means that Millom will be busier than it has been for months. Foreign ore is in bigger demand, and there is an increase in imports from Spain and Norway.

Steel.

There is a better tone in the steel trade, and more orders are obtainable. The outlook is better. The Workington mills have orders sufficiently heavy to keep them going three weeks in every month, and the prospects of further orders are not remote. At Barrow the rail mills are engaged, and last week there was a shipment of rails to Capetown. The small section and hoop mills are fairly well off for orders.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trades.

BUYING of crude steel, pig iron and semi-finished material records no improvement, and little is expected until the New Year. Here and there one hears of developments of a small character, but there is nothing very permanent about them, and the general level of business can be taken as being unaltered. Business is very keenly competed for, and something approaching bargain prices are being obtained by those who have substantial work to offer. In spite of these conditions, however, the general feeling is one of optimism. It is, of course, difficult to gauge the tendency among so many enormous and varied works, but the steady though slight improvement in the number of steel workers employed and a rough survey of the past quarter's working, certainly indicate that trade is on the upward move. Many individual firms report a decided improvement, and whilst others are not so favourably placed as this, they at least record that they are not losing ground. One point of interest to note is the forward inquiry that is being made, and it is believed that some good buying will be seen as soon as the Christmas holidays are out of the way. The year will finish with stocks in the hands of most firms at a very low point, and a little more of the speculative attitude should result in the placing of work that is considerably overdue. Sheffield makers would prefer the progress to be of a steady character, for though present prices are unremunerative, no one wants the market to be "rushed" in a manner that would only result in a reaction. Conditions in the heavy steel trade are very sensitive with buyers so cautious and alert, and price undercutting by foreign firms is a great obstacle.

Engineering Departments.

Railway and shipbuilding work is scarce, particularly the latter, and only a very small proportion of the armament plant is in commission. Rods, bars and similar lines are also experiencing a wave of depression. Departments that are fairly busy are those producing engineering parts made from alloy steels, and tram-track work. A large tramway lay out of manganese steel for Auckland, New Zealand, has been completed recently by Edgar Allen and Co., Ltd., of Sheffield. The lay-out measures 160ft. by 150ft., and consists of sixteen pairs of Edgar Allen double-tongue points, with "bighead" tongues and "Acme" heel adjusters, which are now a standard point for trackwork. There are 88 crossings of all types. All the intermediate rails were also cast in manganese steel, no rolled rails being used. The Sheffield tool trade remains fairly brisk, the best lines being saws, files, and edge tools. Although the oversea business is fairly substantial there is a great deal of room for improvement. Sheffield nowadays hardly touches several once valuable markets, owing to tariffs and foreign competition, but keener attention is being paid to conditions abroad, and in several cases the results have been encouraging.

Valuable Electrical Contract.

The Attercliffe Works, Sheffield, of Metropolitan-Vickers Electrical Company, Ltd., are to receive the greater part of an order which this company has received from Leeds Tramway Committee for 150 electrical equipments for tramcars. The price is £570 per equipment, the full value of the contract thus being £85,500. Each equipment includes two motors, and all the 300 are to be made in Sheffield. The remaining electrical equipment, including the controllers, will be constructed at the company's Trafford Park Works, Manchester. About a month ago the Metropolitan-Vickers firm secured for its Sheffield works an order for 100 tramcar motors at £333 each for Sheffield Corporation, and that, with the Leeds order, will keep the staff there well employed for a considerable time. The 150 cars in connection with which Metropolitan-Vickers have received this order are part of a purchase of 200 on which the Leeds City Council decided some time ago. Ten cars were ordered shortly afterwards, and contracts for 190 trucks were let to the Electro-Mechanical Brake Company. The order for the 150 car bodies has been divided equally between the English Electric Company, Preston, and the Brush Electrical Engineering Company, Loughborough. Consideration of the letting of the contract for the remaining sets of electrical equipment has been adjourned for the result of certain tests.

Plate and Cutlery.

Manufacturers are now having to fall back on plate and cutlery business that is arriving through the normal trade channels. The special Christmas trade is practically at an end, after tailing off badly in the last few weeks. Orders arriving are mostly for small lots, and prices are being kept low by the keen competition that prevails, particularly for stainless cutlery, and the cheaper qualities of plate, which constitute the bulk of the business now passing. Useful orders continue to be received from large catering establishments. Expert opinion in the cutlery trade is almost unanimously in favour of the Government's proposals for imposing a 33⅓ per cent. *ad valorem* duty on imported cutlery, the only question being whether the duty is sufficiently heavy adequately to serve the purpose for which it is intended. The difference between the prices in this country of Sheffield and foreign-made articles is considerably more than will be covered by that percentage—it may be recalled that a figure of 66 was suggested before the Cutlery Committee—but on the principle that something is better than nothing the duty proposed is very acceptable. Another feature which has given great satisfaction is this demonstration of the Government's interest in this important Sheffield industry. No opposition has been forthcoming to the new Home Office regulations dealing with grinding shops, the draft of which was circulated some moths ago, and these will come into operation on January 1st next, with the exception of certain proposals which would involve expensive structural alterations to existing buildings. These proposals have been postponed for three years to enable proprietors to install grinding machines and substitute artificial wheels for the old sandstones. In the case of works erected after January 1st a separate shop must be set apart for dry grinding.

Bridge Building Proposals.

In its next Parliamentary Bill Hull Corporation has decided to include a proposal for a new North Bridge over the river Hull, which, with approaches, will cost £275,000. The bridge, which will connect the eastern and western parts of the city, will carry a double tramway track. The actual cost of the bridge will be £97,694, towards which it is expected the Ministry of Transport will make a grant of from 50 to 60 per cent. A grant of £10,000 is also expected from the Tramways Committee for tramway tracks over the bridge. It is estimated that the work will take seven years to complete. The London and North-Eastern Railway Company is going to complete the New Holland pontoon with an additional landing stage on the Lincolnshire side of the river Humber, at a cost of £84,000. On the opposite side, where the Hull pier is the property of the Corporation, there is a very unsatisfactory landing stage, and with the railway company making this move on the one side those interested are wondering what will be the response on the Yorkshire side. A scheme for providing an adequate landing stage at Hull was included in a Parliamentary Bill, but it was rejected at a statutory town's meeting.

Beet Sugar Factories.

Now that the necessary acreage has been practically assured, it has been decided to proceed at once with the erection of the beet sugar factory at Bardney. The contract has been signed, and it is expected that the factory will be in working order by next September. In connection with the beet sugar industry in East Yorkshire —factories are being erected at Selby and York—freight centres are being established there and at Boroughbridge and Beverley.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

ALTHOUGH considerable leeway has yet to be made up before anything like a normal state of activity is reached in industrial circles in the North of England, there is no disputing the fact that the position is improving almost daily, and everything is tending in the right direction. As is usual at this period of the year, when firms are busily engaged on their annual stocktaking, some falling off in trade is noticeable, but quite an optimistic feeling prevails, and the general view taken is that after the Christmas holidays steady progress in the direction of revival of trade will be experienced. In the iron and steel trades the outlook has improved perceptibly, and the fact that manufacturers are now competing on more favourable terms with foreign producers is encouraging. Orders are being secured in face of the severest continental competition. The prospects for shipbuilding and ship-repairing in the Tyneside area have been further improved by the receipt of new orders by the Palmer Shipbuilding Company, Jarrow and Hebburn. The firm has booked an order for two oil-carrying vessels for the Gulf Refining Company, of Philadelphia, U.S.A., the machinery for which will be constructed by Maccoll and Pollock, Sunderland. In addition to these orders, the Palmer Company has secured the contract for reconditioning the Melita, a vessel of 14,000 tons, belonging to the Canadian Pacific Railway Company, which is a sister ship to the Minnedosa, which is due at Hawthorn, Leslie and Co.'s yard, Hebburn, for reconditioning.

Cleveland Iron Trade.

Quieter conditions now prevail in the Cleveland pig iron trade. Naturally works which are contemplating a stoppage at Christmas do not care to burden themselves unnecessarily with pig iron deliveries, and having covered their immediate needs in most cases, are able to wait until the turn of the year before making fresh purchases. However, if consumers are comfortably situated, so, too, are the ironmasters, who all sold heavily last month, and they consequently have no anxiety about the disposal of the current output. Thus there is not the slightest indication of any weakening in prices. On the contrary, all the Cleveland makers' agreed minima have been strictly adhered to, and such business as has been done has been at these prices, which are as follows:—No. 1 foundry, 69s.; No. 3 G.M.B. Cleveland, 66s. 6d.; No. 4 foundry, 65s. 6d.; No. 4 forge, 65s.; and mottled and white iron, 64s. 6d. per ton. All export quotations are 6d. more than the foregoing.

Hematite Pig Iron.

The East Coast hematite pig iron trade is in an exceptionally strong position. Deliveries are still short, the demand is active, and with the steel works needing a good deal more iron, the extra output of the recently re-started blast-furnaces is urgently needed. There are no fixed minimum prices in the hematite trade, but as higher fuel costs hit the hematite makers just as hard as the producers of other classes of iron, they, too, have felt justified in advancing quotations by 6d. to 75s. 6d. per ton for mixed numbers and 76s. for No. 1 quality.

Iron-making Materials.

Foreign ore prices show an upward tendency. Freights are also advancing, with the result that business in foreign ore is reported at a price equal to 21s. 6d. per ton for best Rubio. Coke prices are very firm, and 21s. per ton is quite a minimum figure for good Durham furnace coke delivered at the works.

Manufactured Iron and Steel.

Quite an active flow of orders is reported in the manufactured iron and steel trade. The works on the North-East Coast are much better employed, and although prices continue to be very depressed, the future is regarded with a good deal less anxiety. Rails are an active market, and a few small orders for plates and other shipbuilding requisites are reported to have been placed.

Iron and Steel Imports.

Statistics presented at this week's meeting of the Tees Conservancy Commissioners showed that the imports of iron and steel during November from European countries, India and coastwise amounted to 16,236 tons, comprising 12,075 tons of crude sheet bars, billets, blooms, &c., 2829 tons of pig iron, and 1332 tons of plates, bars, angles, joists, &c., as compared with a grand total of 16,392 tons in October, 12,367 tons in November, 1924, and 5048 tons in November, 1913.

The Coal Trade.

The Northern coal trade shows an improved tendency as compared with the position a week ago. With tonnage arrivals better than might have been expected, in consequence of the wintry conditions, the market is steadier all round. There is a good inquiry though actual business does not mature very quickly. Some collieries are well supplied with tonnage, but with the remainder the conditions are irregular. With a rather improved stemming situation, there appears to be added interest in Northumberland steam coals, and while actual business bears small relation to the demand, the market all round is steadier. Best steams for prompt are steady, and in second hands are still 15s., while the direct quotation is firmer at 15s. 3d. Other steam coals are also unchanged at 14s. 3d. to 14s. 6d. for Tyne primes and 14s. to 14s. 3d. for seconds, but the tone is improving. Steam smalls are quiet, but fairly steady. and there are not many supplies. Bests are well held at 9s. 6d., and seconds remain at 8s. 6d., and specials at 9s. 9d. There is little change in the Durham market, which remains firm. Business moves in moderate volume, and the output is very well absorbed. Gas coals remain in steady demand at the late values of 16s. 6d. for best grades and 16s. to 16s. 3d. for other good qualities. Seconds are firm at 15s. to 15s. 6d., the demand outweighing the supply. Coking coals are selling moderately well at the full values of 15s. and 15s. 6d., and, being already comfortably sold, are rather firm in feeling. Practically all the favoured branches of the coke trade are in rather enviable circumstances. The output for this month is almost covered, and the demand remaining is large. Gas makes can readily obtain the firm values of 24s. to 25s., and patent foundry is fully held at 22s. to 23s.

The North Tees Power Station Fire.

The Newcastle-upon-Tyne Electric Supply Company, Ltd., has taken steps to correct the many inaccurate and grossly exaggerated statements regarding the fire which occurred in the North Tees Power Station switch-house on November 26th. It has been stated, the company says, that "half a million gallons of oil was involved in the conflagration;" that this quantity of oil "was stored in part of the power station building;" that the switch-house was "gutted"; and that "all that remained of the switch-house was a heap of tangled iron." The facts are that less than 200 gallons of switch oil were burnt; no oil whatever is stored in any of the power station buildings; only two out of the twenty Reyrolle metal-clad switches installed in the switch-house were damaged as a result of the fire; the whole of the switchgear, with the exception of the panels affected, was put back into commission soon after the fire was extinguished, and the power station was dealing with the normal load within eighteen hours of the commencement of the outbreak; supply to a large number of local consumers affected was provided from the company's other sources of supply within a very short period.

SCOTLAND.

(From our own Correspondent.)

Fresh Move in Oil Dispute.

IT has now been agreed to set up a new committee of inquiry on the dispute in the shale oil industry. This committee will consist of two representatives nominated by the employers and two by the workers, with a neutral chairman appointed by the Ministry of Labour. This move is the outcome of a meeting of the Executive Council of the Shale Miners' and Oil Workers' Association, which met to consider the new terms of settlement negotiated between the British Trade Union Congress, the Scottish Trade Union Congress, and Scottish Oils, Ltd. Under the

new agreement, on receipt of the committee's finding, preparatory work will be resumed at 70 per cent. of the mines and works, pending the finding of the court of inquiry, and maintenance men will be engaged at the old rate of wages pending the result of the inquiry. The main question to be decided is whether Scottish Oils, Ltd., is so identical with the subsidiary oil company that the profits should be regarded as common to both. Should the answer be in the affirmative, no reduction in wages will follow, but if in the negative the 10 per cent. reduction proposed by the employers on November 11th last will become effective. Under the original proposal wages over 7s. per day were to be reduced 10 per cent., 7s. per day 5 per cent., and under 7s. per day no reduction. Further, the company was prepared to make good any reduction if profits were earned during the year to the amount of such reductions. The men refused these terms on the advice of their leaders, and there is every probability that the new terms will not work out so favourably. Even as things are now, a considerable period must elapse ere full working conditions can be re-established.

Pig Iron.

The present restricted output of pig iron is still more than adequate to meet all demands, either home or export, and though prices are nominally unchanged, a good order could be placed on much more advantageous terms.

Steel.

In most branches of the steel trade conditions remain quiet. Makers have difficulty in securing specifications, and plants are irregularly employed. In many cases a stoppage has to be resorted to until sufficient tonnage accumulates to warrant a restart. Practically all classes of material are affected, and in this connection the increase in shipbuilding contracts, though these are not yet very satisfactory, is taken as a hopeful sign. Prices of boiler plates, ship plates, and sections are unchanged from last week.

Steel Sheets.

Steel sheets are comparatively busy. Makers report increasing orders for black sheets and prices incline upwards, while galvanised corrugated sheets have been raised 5s. per ton to £18 per ton for 24 gauge for export.

Bar Iron.

Bar iron has a poor market, and the position is not likely to improve in face of foreign competition, and the substitution of steel for iron by many home consumers, owing to the cheaper cost of the former. Re-rolled steel is not very much better off than iron.

Coal.

Shipments of coal from Scottish ports have been heavy, owing to steamers, which had been delayed by the recent stormy weather, coming in. The collieries have been busy overtaking arrears, but are not particularly pressed for fresh supplies. Italy and Germany have been more prominent, but orders are still of a hand-to-mouth description. Lanarkshire splints are firmer and ells are steadier, the latter owing to larger home demands. Fifeshire steams are not so firm, shipping tonnage being somewhat difficult to secure, while most qualities of Lothians fuel are feeling the effect of the industrial trouble in the district. Washed materials on the whole are well held, with pearls showing a tendency to appreciate. Aggregate shipments amounted to 290,375 tons, against 259,078 tons in the preceding week, and 275,449 tons in the same week last year. The feature at present is the increased demand for fuel for home delivery.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE has been extremely little market movement during the past week, but there is some satisfaction in the fact that values have been maintained, while it is of interest to note that foreign exports for the week ended the 4th inst., showed a distinct improvement upon the figures for the four previous weeks. The prospect is that these more favourable conditions as regards activity at the loading ports will be maintained during the next fortnight or so, as the tonnage to hand keeps up to a fair level, and most collieries are pretty well booked. Up to the present, there has been no development concerning buying of coals for delivery over next year, so far as the average consumer abroad is affected, and from all accounts the owners of foreign coaling stations are not yet operating, though as a rule they cover for a portion of their requirements no matter what the outlook is like. Since writing a week ago, news has come to hand respecting business which creates more than ordinary interest. In the first place, the British Admiralty authorities have contracted for their steam coal requirements over 1926, and it is understood that the prices range from 21s. to 22s., according to the grade of the coal. As to what the total quantity is that they have contracted for, there is no means of ascertaining, though it is believed that it amounts to about 200,000 tons. That is an estimate, though there is reason to believe that the purchases from the various collieries are less than those for the current year, during which the Admiralty is credited with having taken about 300,000 tons. Information has also been received regarding the tendering for the requirements of the Egyptian State Railways of 200,000 metric tons of leading Monmouthshire or Cardiff large steam coals suitable for locomotive purposes. These coals have to be delivered at Alexandria during the first four months of next year. At the moment of writing, the railway authorities have not actually placed the contract, but it is fully expected that it will come to South Wales, and that the whole of the order will be secured by Messrs. Watts, Watts and Co., who put in the lowest price of 28s. 9d. net, c.i.f. Alexandria. From all accounts, the tender nearest to that figure was about 1s. higher. The price of 28s. 9d. is regarded as very low, and only a firm which controls a large fleet of suitable steamers and has associated with it a colliery producing the type of coals required by the railways could take the risk of competing on such a basis. The previous contract of the Egyptian State Railways was placed in March with the same firm at the c.i.f. price of 34s. 4d., while the order before that was divided between two firms at 34s. 11d. and 34s. 8½d. per ton respectively. Although nothing official is known, it is reported on the market that very considerable quantities of coal, principally Monmouthshires, have been sold to South American railways for delivery over 1926. One of the railways which has contracted is the Buenos Aires Pacific Company. It is understood that the total purchases run to over a quarter of a million tons.

Chamber of Commerce and Admiralty.

According to Sir William Seager, who is the President of the Cardiff Chamber of Commerce, that body intends going to see the Admiralty authorities and to endeavour to get them to revert to coal instead of consuming so much oil. In a speech Sir William said that it seemed to him uneconomical to buy oil from a foreign country when the best steam coal was available in their own country. Before the war the Admiralty took a million tons more coal per annum than it did now, and it was the Chamber's intention to see if it could not bring back that million tons of trade. So far no arrangement has been made for an interview with the authorities, but it is first proposed that the question should be raised in Parliament by one of the local members—Mr. Lewis Lougher—as to the possibility and practicability of conversion of steamers for the consumption of coal, &c. When that information and other details are available, the Council of the Cardiff Chamber of Commerce will consider the matter, and bring it before a full meeting of the Chamber, after which it is hoped that an interview with the authorities will be secured.

Coal Trade and Subsidy.

The announcement of the Government that it has been decided to ask for a further £9,000,000, making £19,000,000 in all, so far as the present financial year is concerned, for the purposes of the coal mining subsidy, is interesting, but creates no surprise. The opinion in this district is that the subsidy will run to 25 to 30 millions by May next. The audit for the South Wales coalfield for the three months ending October last shows that for the month of December the wage liability of the owners will be below the 1915 standard rates. The liability of the coalowners in October was for the payment of 4.76 per cent. on the 1915 standard rates, and in November 1.64 per cent. on the standard rates. The liability of the owners for the present month will be limited to the standard rates minus 7.22 per cent., which means that not only the whole of the minimum of 42.22 per cent. will have to be met out of the subsidy, but also a small part even of the standard wage, or in the aggregate a sum equal to 29.44 per cent. on the standard rates. This is the first audit in which the returns are limited to the subvention period, as it covers the three months of August, September and October.

Coalfield Holidays.

The official holidays for the miners in this district at Christmas will be two days, viz., the 25th and 26th inst.

Tin-plate Wages.

A meeting of the workmen's representatives of the tin-plate trade and their members on the Joint Industrial Committee was held at Swansea on Monday, when it was decided to call a conference representing all branches of the unions affiliated to the Joint Council for Saturday, January 23rd, to consider matters concerning the sliding scale. The question will then be decided what further action shall be taken in view of the fact that the proposals of the men have been rejected by the employers. The branches will be asked to say whether they are prepared to take fresh action to bring about some alteration in the sliding scale basis, or whether they will make no new general claims and will accept the *ex gratia* payment now given them of 7½ per cent. for another month.

Current Business.

The general tone of the steam coal market has been well upheld during the past week. Most of the leading undertakings are comfortably stemmed for the next week or two, and should be able to work fairly regularly, if only tonnage comes along to time. New business is not, however, active, and appears to be rather quieter if anything, and this is likely to be the case until probably the early part of the New Year. The Greek State Railways have bought 10,000 tons of best Admiralty large and 5000 tons of patent fuel for December-January shipment, and one of the Spanish railways is in the market for 10,000 or 20,000 tons of small for delivery over the first six months or over the whole of next year. The feature of the current market is the continued firmness of small coals. All grades are more difficult to obtain, though some of the superior qualities are practically unobtainable for early shipment. Coke and patent fuel remain without change, and the anthracite coal market keeps steady. Shipments of anthracite continue fairly active for America, though new inquiry from this quarter is still limited, notwithstanding that the strike of the American anthracite miners remains unsettled.

EDUCATIONAL INTELLIGENCE.

OPEN SCHOLARSHIPS IN ENGINEERING.—The Governors of Loughborough College invite applications for the award of five open scholarships in the Faculty of Engineering, each of the value of £75 per annum. The scholarships are open to British subjects situate in any part of the Empire, and are tenable at Loughborough College, Leics., England, for the period of the full diploma course. The entrance examination for the session 1926–27 will take place on Wednesday, Thursday, and Friday, May 27th, 28th, and 29th, 1926. All applicants must be not less than sixteen years of age on October 1st, 1926. Further particulars and application forms may be obtained from the College Registrar.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that the Nethan Ironworks, Motherwell, associated with the name of the late Mr. C. F. MacLaren, have just been purchased by Fredk. Braby and Co., Ltd., Glasgow.

WE are informed that the Usines Carels Frères, of Ghent, now known as the Société d'Electricité et de Mécanique Procédés Thomson-Houston et Carels, trading as S.E.M., has taken out a licence from the Ingersoll-Rand Company to build solid injection cold-starting engines of the latter firm's Price type. The agents in this country for these engines will be Carels Diesel and Steam Engines (London), Ltd., and the Ingersoll-Rand Company, Ltd.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY.—At the suggestion of the Council of the Faraday Society, one of whose objects is to promote the study of electro-chemistry and electro-metallurgy, a small provisional committee was recently formed to take steps to found an Electroplaters' and Depositors' Technical Society, and at a well-attended meeting held at the Northampton Polytechnic Institute on November 11th, 1925, this Society was formally inaugurated. All actually engaged in some responsible position in electro-deposition or in the scientific study of the subject are eligible for membership. The first general meeting was held on December 9th, when Mr. S. Field presented a paper entitled "Electro-deposition: A Survey of Modern Progress." The honorary secretary is Mr. William E. Harris, 193, Eversleigh-road, Battersea, S.W. 11.

THE HUMAN FACTOR IN INDUSTRY.—The following communication has been sent to us for publication:—From recent correspondence in the Press, it is apparent that the vital importance of improved relations and a better spirit between employers and workpeople is becoming more widely recognised. We, the undersigned member firms of the Industrial Welfare Society, offer the view, from our own experience, that the fundamental step towards better relations is a consideration, in each individual organisation, of the human needs of the employees. To the modern industrial or commercial firm, the safeguarding of the health, safety, comfort and security of the worker is not in any sense philanthropy: it is good management, and brings the rewards of good management in a healthy, loyal and stabilised working force. Mention has been made in the Press of the need for recognised sources from which information in connection with industrial relations could be secured. We should like to point out that there already exists, in the Industrial Welfare Society, a body founded in 1918, which possesses an immense store of practical information gathered from every industrial country in the world. Industrial and commercial firms who wish to investigate for themselves simple methods by which they can give practical expression to their desire for a new spirit in their organisations could not do better than consult the Society at 51, Palace-street, Westminster, S.W. 1. The signatory firms number over seventy, and very many of them are engineers.

PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.—As previously announced, the Sixteenth Annual Exhibition of the Physical Society of London and the Optical Society is to be held on Tuesday, Wednesday and Thursday, January 5th, 6th and 7th, 1926, at the Imperial College of Science and Technology, Imperial Institute-road, South Kensington. It will be open in the afternoon from 3 to 6 p.m. and in the evening from 7 to 10 p.m. each day. Mr. J. E. Barnard, F.R.S., will give a lecture on "The Search for Ultra-Microscopic Organisms," at 8 p.m. on January 5th; Professor A. F. C. Pollard, A.M.I.E.E., will give a lecture on "The Mechanical Design of Instruments," at 8 p.m., on January 6th; and Major W. S. Tucker, D.Sc., will give a lecture on "Electrical Listening," at 8 p.m., on January 7th. These lectures will be illustrated by lantern slides and experiments. Some seventy firms will, we gather, exhibit scientific apparatus, and, in addition, there will be a group of non-commercial exhibits by Fellows of the Societies and others, including demonstrations of famous historical experiments in physics, recent physical research and effective lecture experiments. It has been decided to open the Exhibition to the general public without tickets on the third day, January 7th. On January 5th and 6th tickets of admission will be required. We understand that invitations relating to January 5th and 6th have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Radio Society of Great Britain, the Rontgen Society, the Faraday Society, and other scientific societies. Members of such societies should apply for tickets to the secretary of the Society to which they belong. Others interested should apply direct to Professor A. O. Rankine, Imperial College of Science and Technology, South Kensington, S.W. 7.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, December 7th, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Dr. W. Rushton Parker for his donation of £100 towards the improvement of the library. Mr. W. G. Bruty, Dr. P. C. Buck, Mr. J. R. Cousins, Mr. J. Scott Duckers, Mr. A. Edmunds, Mr. M. A. Greig, Mr. E. Marsden, Mrs. Murray, Lieut.-Colonel B. C. Quill, Mr. A. L. Reckitt, Miss E. M. Slear, Mr. J. A. Stevenson, and Mr. H. B. Gordon Warren were elected members. The lecture arrangements for the before Easter session next year were announced as follows:—The Juvenile Lectures, the hundredth course, will be delivered by Sir William Bragg, on "Old Trades and New Knowledge," commencing on December 29th at three o'clock. On Tuesdays, at 5.15, beginning on January 19th, there will be two lectures by Dr. J. A. Crowther, on "X-rays and Living Matter;" two by Dr. E. K. Rideal, on "Surface Action;" four by Professor Barcroft, on "The Egg;" and two by Dr. C. H. Desch, on "The Growth of Crystals." On Thursday, January 21st, at the same hour, Dr. C. J. Patten will give the first of two lectures on (1) "The Language of Birds," (2) "The Breeding Factor in Birds." These will be followed by three lectures by Dr. J. L. Myres on "Who were the Greeks?" three by Dr. C. D. Ellis on "The Atom of Light and the Atom of Electricity," two by Dr. J. Holland Rose on "Indecisiveness of Modern Warfare." On Saturday afternoons at three o'clock Mr. Henry Balfour will give two lectures, commencing on January 23rd, on (1) "The Evolution of Currency and Coinage," (2) "The British Coracle, or the Skin-covered Boat and its Affinities." On succeeding Saturday afternoons there will be two lectures on "The Nature and History of the Triad" and "The Perfect Fourth," by Sir Walford Davies, with musical illustration; two by Dr. George Macdonald, on "Roman Britain," and four by Sir Ernest Rutherford on "The Rare Gases of the Atmosphere and their Importance in Atomic Theory." The Friday evening meetings will begin on January 22nd, when Sir William Bragg will deliver a discourse on "The Work of the Davy Faraday Research Laboratory." Succeeding discourses will probably be given by Sir William Hardy, Professor George Gordon, Professor Robert Robinson, the Hon. J. W. Fortescue, Dr. C. Hagberg Wright, Sir J. J. Thomson, Mr. John Tweed, Sir Ernest Rutherford, and others.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	21/-
(1) Spanish	18 6
(1) N. African	18/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) Scotland—		
Hematite	3 18 6	—
No. 1 Foundry	4 0 0 to 4 2 6	
No. 3 Foundry	3 17 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 15 6	3 15 6
No. 1	3 16 0	3 16 0
Cleveland—		
No. 1	3 9 0	3 9 6
Silicious Iron	3 9 0	3 9 6
No. 3 G.M.B	3 6 6	3 7 0
No. 4 Foundry	3 5 6	3 6 0
No. 4 Forge	3 5 0	3 5 6
Mottled	3 4 6	3 5 0
White	3 4 6	3 5 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 2 0	—
,, Forge	2 16 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 0 to 3 6 0	
Forge	3 2 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 6 0 (a); 4 8 6 (b); 4 13 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best ,,	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	11 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up.	7 12 6 to 7 15 0	
Sections	7 5 0	—
Steel Sheets, under 3/16in. to ¼in.	9 5 0 to 9 7 6	
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	7 5 0	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†..	—
Light ,,	8 5 0 to 8 10 0	
Billets	7 10 0 to 10 10 0†	
Manchester—		
Bars (Round)	8 5 0 to 9 0 0	
,, (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	7 17 6 to 8 5 0	
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
Midlands—		
Small Rolled Bars	7 17 6 to 8 0 0	
Billets and Sheet-bars	6 0 0 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 12 6 to 16 15 0	
Angles	7 2 6 to 7 7 6	
Joists	7 2 6 to 7 7 6	
Tees	8 2 6 to 8 7 6	
Bridge and Tank Plates	7 17 6 to 8 0 0	
Boiler Plates	11 0 0 to 12 0 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/9 to 20/3
Block Tin (cash)	286 17 6
,, (three months)	280 5 0
Copper (cash)	59 7 6
,, (three months)	60 7 6
Spanish Lead (cash)	34 12 6
,, (three months)	34 1 3
Spelter (cash)	38 10 0
,, (three months)	37 12 6
Manchester—	
Copper, Best Selected Ingots	65 0 0
,, Electrolytic	67 0 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis price)	0 1 0
,, Condenser	0 1 2½
Lead, English	38 10 0
,, Foreign	35 10 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/8 to 1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 0 0	7/9
,, 8 p.c. to 10 p.c. ,,	£22 10 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£40 10 0	15/-
,, ,, 1 p.c. ,,	£50 0 0	17/-
,, ,, 0.70 p.c. carbon	£56 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	3/9 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	€11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£21 0 0 scale 6/- per unit	
,, Vanadium	15/6 per lb.	
,, Molybdenum	6/3 per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£172 to £177	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/-
,, ,, Ell	16/-
,, ,, Splint	17/- to 19/-
,, ,, Trebles	17/6
,, ,, Doubles	16/9
,, ,, Singles	14/9
Ayrshire—	
(f.o.b. Ports)—Steam	15/-
,, ,, Splints	17/-
,, ,, Trebles	17/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 15/3
Screened Navigation	20/9
Trebles	18/- to 19/-
Doubles	16/6
Singles	14/9
Lothians—	
(f.o.b. Leith)—Best Steam	15/-
Secondary Steam	14/6
Trebles	16/6
Doubles	16/6
Singles	14/9

ENGLAND.

	Inland.	Export.
(8) N.W. Coast—		
Steams		23/6
Household		40/- to 45/-
Coke		26/-
Northumberland—		
Best Steams		15/6
Second Steams		14/6
Steam Smalls		10/- to 10/3
Unscreened		14/-
Household		20/- to 22/-
Durham—		
Best Gas		16/- to 16/6
Second		14/6 to 15/-
Household		20/- to 22/-
Foundry Coke		20/- to 22/6
Sheffield—		
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	24/- to 26/6	—
,, ,, House	23/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	16/6 to 19/6	—
Derbyshire ,,	16/- to 19/-	—
Rough Slacks	9/6 to 12/6	—
Nutty ,,	6/- to 7/6	—
Smalls	3/6 to 5/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)		f.o.b. 18/3 to 18/9

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	23/- to 23/6
Second ,, ,,	21/6 to 22/6
Best Dry Large	22/6 to 23/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	20/- to 20/6
Western Valley ,,	19/- to 20/-
Best Eastern Valley Large	19/- to 19/6
Ordinary ,, ,,	18/9 to 19/-
Best Steam Smalls	12/6 to 13/6
Ordinary ,,	10/- to 12/-
Washed Nuts	19/- to 20/6
No. 3 Rhondda Large	26/6 to 27/6
,, ,, Smalls	16/6 to 17/6
No. 2 ,, Large	18/6 to 19/-
,, ,, Through	16/- to 17/-
,, ,, Smalls	10/6 to 11/-
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/6 to 22/6
Pitwood (ex ship)	31/- to 32/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	38/- to 42/-
Seconds	32/6 to 37/6
Red Vein	27/6 to 31/-
Machine-made Cobbles	55/- to 57/6
Nuts	55/- to 57/6
Beans	42/- to 43/6
Peas	20/- to 24/-
Breaker Duff	7/- to 8/-
Rubbly Culm	12/- to 12/3
Steam Coals:	
Large	22/- to 23/6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/6 to 18/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Taxes and Trade.

THE new Bill for increasing the taxes upon industry is naturally provoking hostile criticism from manufacturers, who declare that these higher charges will seriously compromise the situation by inflating production costs to a level beyond the possibility of consumers to pay. It is certain that in a general way the steadily increasing costs have for a long while past been accompanied by a diminishing consumption, and more especially by the employment of economical methods, which do not always imply a maintenance of the standard of quality and durability, and it is therefore probable that the additional charges will be detrimental to business for some time to come. Nevertheless, it may prove to be merely a disagreeable phase in the process of reorganisation, for, if the revenue from the new taxes enable the Government to carry out the measures necessary to stabilise the franc, the causes of the present fluctuations will disappear and a revival of confidence will bring about a recovery of business. For the moment confidence is wanting, even in the methods which the Government is employing to place the country's finances on a satisfactory basis, while underlying the hostility of manufacturers to the new measures is the fear that, in the event of a too sudden appreciation of the franc, they will find themselves disarmed against foreign competition, until such time as there is a readjustment of values to currency.

Public Works.

Soon after the Armistice this country started upon a programme of public works which were intended to lower manufacturing costs and reduce as much as possible the importation of fuel. An accelerated service on an improved and elaborate system of inland waterways would bring down the cost of raw material to the consumer and would permit of the manufacturer sending his products cheaply to the ports of shipment and over the Continent. The waterways would also provide electrical energy, particularly the Rhone and the lateral Rhine canals, while the Alps and the Pyrenees would also contribute to a total of horse-power which, if distributed over the country, would supply nearly all the energy needed for manufacturing purposes. The problem of an economical distribution over long distances is, however, far more difficult than had been anticipated. So far as the existing hydraulic resources are concerned, a good deal of work has already been accomplished, especially for the electrification of railways, but apart from these more urgent undertakings, the execution of the programme has been seriously delayed by financial considerations. A great effort was made to induce Germany to assist in this work on account of reparations, but as the Germans considered that an economic equipment of the country was outside the scope of their obligations, the French have to rely on their own resources which are, for the time being, very restricted. Nevertheless, congresses have been held recently to discuss various economic questions, and it was concluded that the carrying out of public works was an important factor in the country's financial recovery. it was, therefore, proposed that the Government should provide in its yearly budget a sum of 300 million francs for their execution. It is to be presumed that the Government will entertain a different view of the judiciousness of this expenditure of public funds, and it is far more likely that, when provision is made for an adjustment of the country's finances, loans will be raised at home and abroad for the carrying out of works which will provide ample employment for engineering firms and will enhance considerably the country's manufacturing resources.

Traffic and Freights.

The recommendation of the Conseil Supérieur des Chemins de Fer to accept the request of the railway companies to increase still further the railway rates, is based upon the absence of any other possible means of making up for the large deficit of the past year. That deficit appears to be about 700 million francs for all the railway companies, and it is attributed partly to a declension of traffic, but more particularly to the huge additional charges imposed upon the companies by the application of the eight hours' working day. In view of the companies' situation, some tolerance was allowed in the observance of the hours of labour, but, with the arrival of the Socialist party in power, the eight hours' day was strictly enforced, and now that the companies are endeavouring to reduce the deficit by increasing freights, the unions of railwaymen and employees have all united in demanding higher wages. A further loss to the companies arises from the necessity of paying interest on loans in foreign countries with a depreciated currency, and that is estimated at 215 million francs for the past year, thus bringing up the total deficit to 915 million francs. To cover it, it is proposed to increase passenger fares by 100 per cent. on the basis of those ruling before the companies found it necessary to raise the fares. The rates on goods will be increased according to their nature. It is suggested that the higher rates for goods will have the effect of stimulating the competition of motor traffic. It is certain that motor lorries are extending their range of action, which may be expected to increase with the higher railway rates.

Coal Output.

The production of the French collieries during October showed a further increase as compared with the output for the previous month, and for the first ten months of the year it amounted to a total of 39,869,441 tons, as against 37,429,507 tons in the corresponding period of 1924. The exceptional demand for domestic coals is readily absorbing the much larger consignments of British fuel to Rouen. It is nevertheless certain that the efforts to substitute Ruhr coal for the British is having some effect, and another factor of competition is the intention of the Government to authorise the free importation of German coal under conditions that will not weaken the position of the French colliery companies.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

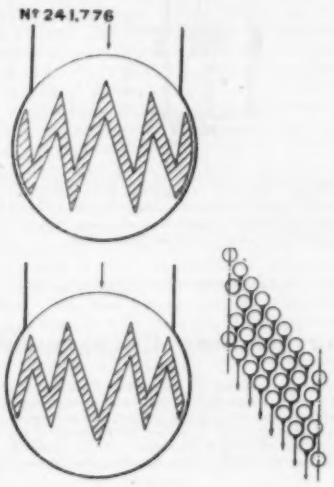
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

241,776. January 30th, 1925.—SURFACE CONDENSERS, Société des Condenseurs Delas, 103, rue Saint-Lazare, Paris, France.

The peculiarity about this condenser is the system of arranging the tubes in such a manner that there are several deep valleys which conduct the steam right into the nest of tubes. Two

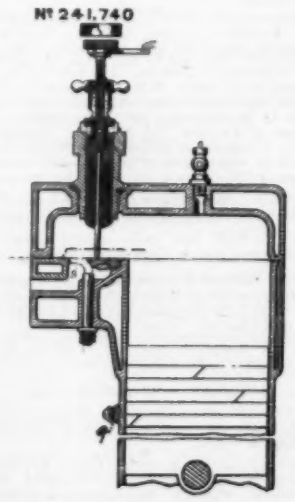


alternative arrangements are shown in the drawing, in which the tubed area is shown by shading. The tubes are disposed, as shown in the detail drawing, in such a manner that the condensate drips off each tube on to the side of the one below and thus does not mask the tube more than necessary. A free outlet to the bottom of the condenser for the condensate is provided by the inverted valleys below.—*October 29th*, 1925.

INTERNAL COMBUSTION ENGINES.

241,740. November 27th, 1924.—SPARKING PLUGS, R. J. Koster and F. E. Bright, 154, West 56th-street, New York, U.S.A.

The inventors use a sparking plug of the general form shown in the illustration and produce the spark between its electrode

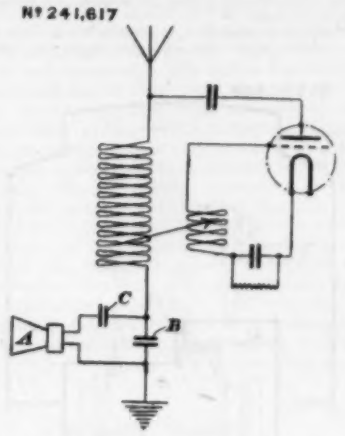


and the wall of the combustion chamber. It is essential that the wall, where the spark is struck, should be flat, and it is stated that in these circumstances carbonization will be avoided. A screw adjustment is provided for regulating the length of the spark gap.—*October 29th*, 1925.

TELEGRAPHS AND TELEPHONES.

241,617. July 21st, 1924.—IMPROVEMENTS IN WIRELESS TELEPHONE TRANSMITTING SYSTEMS, Harold Robert Corby Van De Velde, of "Taplow," Bute-road, Wallington, Surrey; James Stewart, of Aero View, Plough-lane, Surrey; and Edward Herbert Trump, of 22, Bournemouth-road, Merton Park, S.W.

This invention relates to wireless telephone transmitting systems in which speech modulation is obtained by means of a microphone A shunted by a condenser B and connected to the earth lead of the transmitter. When the wave lengths employed are longer than those for which the condenser is suitable excessive currents flow through the microphone, whereas if the wave lengths are shorter than those for which the condenser is suitable the current flowing through the microphone will be insufficient to enable it to control the output of the transmitter to the requisite degree. According to this invention, a condenser C is introduced in series with the microphone, and this condenser and the microphone are shunted

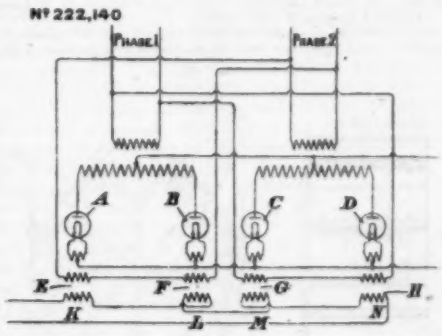


by the main condenser. Good results have been obtained by giving the condenser B a value of ·015 microfarad and the condenser C ·01 microfarad.—*October 21st*, 1925.

TRANSMISSION OF POWER.

222,140. September 19th, 1924.—IMPROVEMENTS IN SYSTEMS OF ELECTRIC DISTRIBUTION, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C.* 2.

In the operation of thermionic electron discharge devices designed for large currents, the magnetic field produced by the current required for heating the cathode tends to prevent the escape of electrons from the cathode, and the object of the present invention is to overcome this defect. The heating current supplied to the cathode is automatically reduced during the periods when the device is carrying current, and the heating current is permitted to reach the maximum value required for

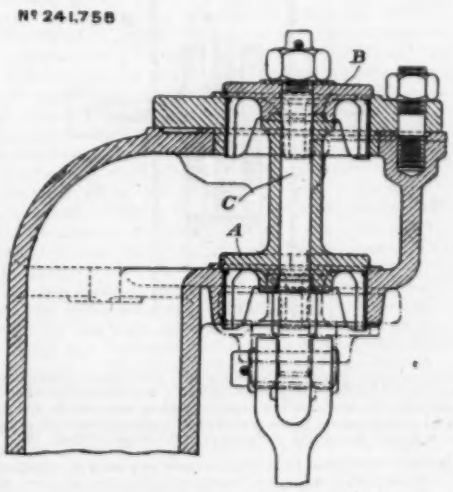


heating the cathode during the periods when the device is not required to carry current. In the diagram four thermionic rectifiers A, B, C and D are used to rectify current from a two-phase alternating-current supply. Heating current for the cathodes of the rectifiers A and B is supplied by transformers E and F, the primary windings of which are connected across the second phase. Similarly the cathodes of the rectifiers C and D are supplied with current from transformers G and H, which are connected across the first phase. The transformers are provided with additional windings K, L, M, N connected as shown, and are supplied with direct current. The theory of the scheme is described.—*October 29th*, 1925.

LOCOMOTIVES.

241,758. December 31st, 1924.—REGULATOR VALVES, Beyer, Peacock and Co. and R. H. Whitelegg, Gorton Foundry, Manchester.

This double-beat valve is fully balanced; that is to say, the two valves are of equal effective area. In order to allow of the

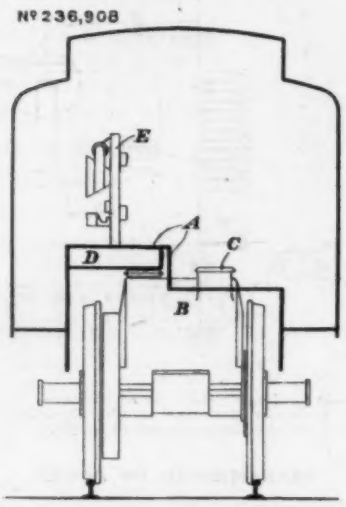


inner valve A being put in place the seating for the upper valve B is detachable and the two valves are separable. The opening for the upper seating is large enough to pass the lower valve, and the two valves are held together by the bolt C.—*October 29th*, 1925.

TRAMWAYS AND RAILWAYS.

236,908. June 9th, 1925.—Improvements in or relating to the Construction of Cabs of Electric Locomotives, *Société Anonyme des Ateliers de Secheron, of Avenue Blanc, Secheron, Geneva.*

This specification describes an electric locomotive cab with a bridge, which carries the electrical apparatus, and which

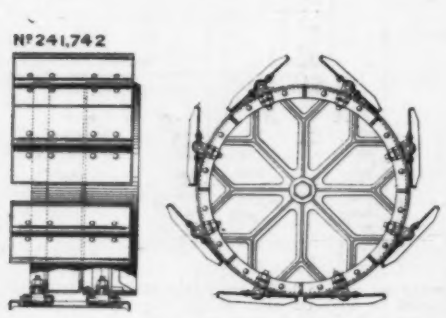


is arranged so that the parts of the driving motors that require attention are accessible. It will be seen that the bridge A partly covers the driving motor B, the commutator cover C of which projects above the bridge. In the highest portion of the bridge there is an air duct D, and above this duct there is the associated electrical apparatus E.—*October 29th*, 1925.

MOTOR CARS AND ROAD TRAFFIC.

241,742. December 1st, 1924.—Traction Wheels, H. McLaren, Midland Engine Works, Leeds.

This invention is concerned with the wheels of tractors and aims at furnishing them with shoes which will provide a good

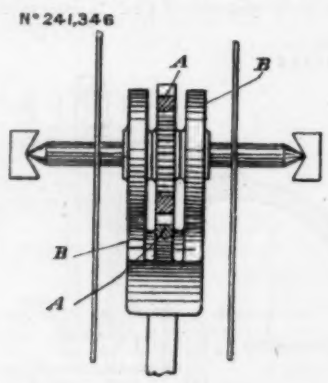


grip on the ground and will enable the machine to travel over soft ground. The shoes are dished, as shown, so that the flanges provide a good grip, and they are attached to the wheel by pivot pins. The shoes are consequently easily attached or taken off.—*October 29th*, 1925.

MISCELLANEOUS.

241,346. September 2nd, 1924.—Toothed Gearing, W. and T. Avery, Ltd., Soho Foundry, Birmingham; and W. A. Benton.

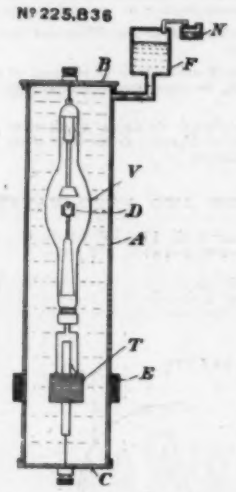
It is suggested in this specification that a toothed gearing can be made anti-frictional by means of the addition of one or two



plain rolling surfaces having diameters and centres corresponding with the intersecting pitch circles of the toothed wheels. It naturally follows that the rolling surfaces must be in contact one with the other. In the drawing the toothed wheels are shown at A A and the rolling surfaces at B B.—*October 22nd*, 1925.

225,836. November 15th, 1924.—Improvements in or relating to High-tension Thermionic Valves, Siemens and Halske Aktiengesellschaft, near Berlin.

This invention relates to the construction of thermionic valve tubes for high-tension rectifying installations, more particularly for X-ray tubes. In view of the very high tensions needed it is frequently necessary to connect several valves in series. According to this invention the space required for such installations is reduced by arranging each of the valve tubes in a container filled with a high-grade fluid insulating material such as oil or compressed air. A cylindrical tube A of hard paper is closed at both ends by covers B and C, which may be made of metal and are used as terminals for the high-tension wires. The tube contains the valve V and a current transformer



T for supplying the cathode D. The primary winding E of the transformer is placed outside the tube. For the purpose of equalising the level of the oil with changes of temperature an oil "conserver" F and a tank N containing moisture-absorbing substances are provided.—*October 29th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Civil Engineers: Birmingham and District Association.—Chamber of Commerce, New-street, Birmingham. Vernon Harcourt Lecture, "The Development of Harbour and Dock Engineering," by Sir Cyril Kirkpatrick. 6 p.m.

Institution of Mechanical Engineers.—General Meeting, Storey's Gate, Westminster. "Cast Iron and Modern Engineering Practice," by J. G. Pearce, and "Some Applications of Research to Modern Foundry Practice," by J. E. Fletcher. 6 p.m.

Institute of Metals: Sheffield Local Section.—Applied Science Department, The University, St. George's-square, Sheffield. Paper, "Nickel Silver," by Professor F. C. Thompson. 7.30 p.m.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Paper, "Modern Metallurgy," by Professor J. H. Andrew. 7.15 p.m.

Junior Institution of Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Induction of and address by the President, Mr. J. S. Highfield. 7.30 p.m.

Physical Society of London.—Imperial College of Science South Kensington, London, S.W. 7. Papers, "The Effect of Rolling on the Crystal Structure of Aluminium," by Dr. E. A. Owen and Mr. G. D. Preston; "On the Spreading of One Liquid on the Surface of Another," by Mr. R. S. Burdon; "On the Advance of the Perihelion of Mercury," by Mr. J. T. Combridge." A demonstration illustrative of phenomena described in Mr. Burdon's paper will be given by Mr. Chas. R. Darling. 5 p.m.

Railway Club.—65, Belgrave-road, London, S.W. 1. Paper, "Some Little Known Features of Railway Publicity," by Mr. J. R. Hind. 7.30 p.m.

SATURDAY, DECEMBER 12th.

Institute of British Foundrymen: Lancashire Branch, Junior Section.—College of Technology, Sackville-street, Manchester. Lecture, "The Physical Testing of Foundry Products," by Mr. J. S. G. Primrose. 7 p.m.

Institute of Marine Engineers.—85-88, The Minories, Tower Hill, London, E. 1. Juniors' Social. 7 p.m.

MONDAY, DECEMBER 14th.

Bradford Engineering Society.—Technical College, Great Horton-road, Bradford. Lecture, "Gas Manufacture," by Mr. E. J. Sutcliffe. 7.30 p.m.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank crescent, Glasgow. Paper, "Aluminium and its Alloys as Used for Engineering Purposes," by Dr. H. Hyman. 7.30 p.m.

Institution of Automobile Engineers: Birmingham Centre.—Chamber of Commerce, New-street, Birmingham. Paper, "Sleeve-Valve Engine Development," by Mr. W. Ferrier Brown. 7 p.m.

Institution of Mechanical Engineers: Graduates Section.—Storey's-gate, Westminster, London, S.W. 1. Paper, "The Mechanical Transmission of Power on Electric Locomotives," by Mr. V. F. Corniah. 7 p.m.

TUESDAY, DECEMBER 15th.

Institute of Marine Engineers.—85-88, The Minories, Tower Hill, London, E. 1. Paper, "Economic Application of the Scott-Still Engine," by Mr. J. A. Sim. 6 p.m.

Institution of Automobile Engineers.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Production," by Mr. J. F. Sturdy. 7.15 p.m.

Institution of Automobile Engineers: Wolverhampton Centre.—Engineering and Scientific Club, Wolverhampton. Paper, "Sleeve-Valve Engine Development," by Mr. W. Ferrier Brown. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Paper, "Pressure-Boosting Station for the Waterworks of Monte Video," by Mr. A. Honnysett. 6 p.m.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Paper, "The Economic Value of Bunker Coal," by Mr. Otto Kahrs. 7.30 p.m.

WEDNESDAY, DECEMBER 16th.

Chemical Engineering Group.—Works visit. Dinner and meeting at Nottingham. 2.30 p.m.

Illuminating Engineering Society.—Lighting Service Bureau, 15, Savoy-street, Strand, London, W.C. 2. Informal meeting. 7 p.m.

Institution of Automobile Engineers.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' Meeting. Paper, "Press Tools," by Mr. F. G. E. Clarke. 7.30 p.m.

Institution of Automobile Engineers: North of England Centre.—College of Technology, Manchester. Several films will be shown. 7 p.m.

Institution of Automobile Engineers.—Watergate House, Adelphi, London, W.C. 2. Graduates' Meeting. Paper, "Sales and Service," by Mr. C. A. Edwards. 7.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Students' meeting. Vernon-Harcourt Lecture, "The Development of Harbour and Dock Engineering," by Sir Cyril R. S. Kirkpatrick. 6 p.m.

Junior Institution of Engineers.—Visit to the works of C. F. Casella and Co., Ltd., Walthamstow. 5 p.m.

Newcomen Society.—Prince Henry's Room, 17, Fleet street, London, E.C. 4. Papers: "History of the Invention of English Flint Glass," by Mr. E. Wyndham Hulme; "History of Copper Ruby Glass," by Mr. J. A. Knowles; "Notes on Early Bridge Construction," by Mr. W. Worby Beaumont. 5.30 p.m.

Society of Glass Technology.—Chemistry Lecture Theatre, University College, Gower-street, London, W.C. 1.—Papers, "The Composition of Glass Suitable for Use in Automatic Machines," by Professor W. E. S. Turner; "The Relationship Between Chemical Composition and the Durability of Glass," by Miss Violet Dimbleby and Professor W. E. S. Turner. 2.30 p.m.

THURSDAY, DECEMBER 17th.

Institution of Automobile Engineers.—Training School, Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Discussion on "The Merits of the Six-cylinder and Straight Eight for Touring Car Work," opened by Messrs. G. L. Ensor and P. White. 7.30 p.m.

Institution of Civil Engineers: Yorkshire Association.—Royal Victoria Hotel, Sheffield. Vernon Harcourt Lecture, "The Development of Harbour and Dock Engineering," by Sir Cyril Kirkpatrick. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "The Power Losses in Magnetic Sheet Material at High Flux Densities," by Mr. C. E. Webb. 6 p.m.

Royal Aeronautical Society.—7, Albemarle-street, London, W. 1. Informal discussion on "Aero-engine Starting Gear." 6 p.m.

FRIDAY, DECEMBER 18th.

Junior Institution of Engineers.—15, Savoy-hill, Strand, London, W.C. 2. Lecture and demonstration of industrial and domestic electric lighting. 7 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Papers, "Some Aspects of the Theory of Ship Waves and Wave Resistance," by Professor T. H. Havelock. 7.30 p.m.

Polytechnic Engineering Society.—Fyvie Hall, 309, Regent-street, London, W. 1. Annual Conversazione. 7.30 p.m.

MONDAY, DECEMBER 21st.

Whitworth Society.—Holborn Restaurant, Kingsway, W.C. 1. Third annual commemoration dinner. 6.30 for 7 p.m.

TUESDAY, DECEMBER 22nd.

Institute of Marine Engineers.—85/88, The Minories, Tower Hill, London, E. 1. Paper, "Fuel Injection," by Mr. C. Hughes. 6.30 p.m.

CONTRACTS.

Harrington travelling grate stokers, constructed by Riley Stoker Company, Ltd., of London, have been exclusively adopted for a new power station at Kirkcaldy, designed by Messrs. Kennedy and Donkin, consulting engineers, of London.

Yarrow and Co. (1922), Ltd., of Scotstoun, Glasgow, inform us that they have secured a contract from the British Admiralty for six of the latest Yarrow patented water-tube boilers (land type) with Yarrow superheaters for the electric power station at Portsmouth Dockyard.

Chambers, Scott and Co., Ltd., of Motherwell, have received from abroad an order for a large grabbing crane or bucket digger which is to be capable of handling over 6 tons of material at each operation, and of discharging at any height of lift. It is to have about 200 horse-power at its command.

The London Underground Railways have placed a contract with James Carmichael, Ltd., for the entire reconstruction of the City Line stations at Clapham-road and the Oval. The schemes of reconstruction provide for the removal of the lifts and the installation of escalators. It is expected that these new stations will be completed by about May of next year.

International Combustion, Ltd., of Africa House, Kingsway, London, W.C. 2, informs us that its associated company in Germany recently received a contract for the equipment of two boilers, each of 20,000 square feet heating surface, and six boilers, each of 15,000 square feet heating surface, with the complete system of Lopulco pulverised fuel firing, for the large power plant at Rummelsburg.

John I. Thornycroft and Co., Ltd., of Thornycroft House, Smith-square, London, S.W. 1, inform us that they have received an order from the Admiralty for a Thornycroft Hathi tractor, similar to the fleet of those vehicles which they have supplied to the War Office. The same firm has also recently received the following orders:—From Australia, for over seventy motor vehicle chassis for loads of from 30 cwt. to 5 tons; for chassis of various types, particularly type A 1 for 30 cwt. loads or passenger vehicles seating up to twenty; and for various types of chassis from Buenos Aires, Rio de Janeiro, Singapore, and Toronto.

Asphalt Mixing Plant.—With reference to the description of the Nacopax bituminous road-making plant which appeared in our issue of November 11th, we are requested by the makers, Davey, Paxman and Co., of Colchester, to state that the machine was designed in conjunction with the Neuchatel Asphalte Company, Ltd., and that they have supplied a large number of these plants to the Neuchatel Company. Among them there are sets working on jobs in Essex, Surrey, Middlesex, Durham, Gloucester, Lanark, and Dumbarton.

A Seven-Day Journal

Sir Alfred Yarrow's Views on the Shipbuilding Position.

ON his return from America, where he has been examining shipbuilding and general trade conditions, Sir Alfred Yarrow, in the course of an interview, has expressed the opinion that so far as shipbuilding is concerned, we have nothing to fear from American competition. The Americans, Sir Alfred said, excelled in mass production, but mass production could not be applied to the building of ships. It was not possible to lay down a hundred Atlantic liners simultaneously, so as to reap the benefit obtainable by producing a large number of one thing at the same time. On the other hand, he was convinced that the United States had a vast degree of commercial prosperity ahead in its own industries, particularly in those dependent upon the oil, fruit and mineral resources of the country. Dealing with the motor ship, Sir Alfred said he thought the steamer would survive for a long time, and if the supply of fuel oil decreased and the price rose, the steamer might continue in use indefinitely. The world's supplies of coal were much greater than its supplies of fuel oil. The future of the motor ship, Sir Alfred held, lay with those who could find the best iron alloy for the construction of the engines, an alloy that would stand the stresses imposed upon it at the very high temperatures involved. Faulty metal, he believed, was largely responsible for past failures of the internal combustion engine. Great Britain could still retain her prestige in the shipbuilding industry, but she would have to fight for it. To that end it was essential that trade union rules should be relaxed and that facilities should be provided for an increased interchangeability of labour.

Waterloo Bridge.

A DEFINITE decision has at last been reached by the London County Council regarding the preservation or rebuilding of Waterloo Bridge. On Tuesday, by 82 votes to 32, it decided that the bridge should be rebuilt to provide room for six lines of vehicular traffic and with not more than five arches. A proposal to ask the Government to appoint a technical commission to investigate the possibility of underpinning the old bridge was rejected. It was urged that underpinning would result in a saving to the ratepayers, but it had to be admitted that of nine engineers consulted on the question, five had stated that the existing bridge could be underpinned, while four had held the opposite opinion. Those in favour of rebuilding the bridge argued that the question revolved itself into a choice of attempting to retain the old bridge as a thing of beauty and an obstruction for ever, or of pulling it down and constructing a new one that would meet present and future requirements. All agreed that from the artistic and sentimental point of view, the destruction of the present bridge was to be regretted, but many held that necessity for increased traffic provision should take precedence over æsthetic considerations. On the score of beauty it was urged that the new bridge need not be less beautiful, and, in fact, might be made more beautiful than the old.

A Malay State Hydro-Electric Scheme.

WE learn that an important concession has been signed by the Federated Malay States Government, under which Sir W. G. Armstrong, Whitworth and Co., Ltd., have been granted rights to develop a hydro-electric power scheme on the Perak River, in the State of Perak. The energy generated is to be applied principally towards the development of the tin fields situated in the Kinta Valley and its neighbourhood, and to cheapen the cost of production in that area. The carrying out of the scheme, we are informed, will involve the purchase in this country, through Messrs. Armstrong, of a large amount of machinery and electrical equipment. The Trades Facilities Act Advisory Committee is supporting the undertaking of the work to the extent of guaranteeing a sum of £1,250,000.

The French Navy.

THE recent debate in the French Chamber of Deputies upon the voting of credits for carrying out the programme of naval construction revealed a reversal of the policy of the late Minister of Marine, who decided to extend the time for the construction of certain vessels belonging to the second instalment of the programme from two to three years. By so doing he sought to show that France was disposed to work for peace in the "spirit of Locarno," and at the same time to effect economies which would place the country in a more satisfactory position when negotiating for a settlement of its international debts. The present Government has now declared that this tampering with the programme was illegal, and it has decided to carry it through according to the original plan. It is pointed out that France has only spent 226 million gold francs upon new construction during the past five years, whereas the expenditure of Great Britain has been 558 millions, that of the United States 1780 millions, and of Japan 2242 millions. It is therefore necessary, it is stated, that France should complete her limited programme as rapidly as possible. It is not proposed to diminish in any way the importance attached to the submarine, which, in the words of the Minister of Marine, is as "legal a weapon as the aeroplane and the big gun." The general tone of the debate was that France must rely upon her own navy, with full liberty to build as many submarines as she pleases, and that there can be no disarmament unless it is made general.

The Mersey Tunnel.

ON Wednesday Princess Mary inaugurated the Mersey Tunnel works by starting the boring of a shaft to be sunk on the site of the old St. George's Dock on the Liverpool side of the river. As stated in last week's issue, the contract for the sinking of the two shafts and for driving the two preliminary headings under the river has been awarded to Messrs. Nuttall, of Trafford Park, at a price of £443,680. This figure, it now appears, was very much less than that submitted by any other Merseyside firm which tendered for the contract. The nearest quotation of any such competing firm is stated to have been approximately £800,000. Messrs. Nuttall have explained that their low quotation was rendered possible by reason of their special experience of and the use of special machinery for boring rock. The tunnel, when finished, will be 44ft. in diameter, and will be lined with cast iron segments rendered internally with concrete. Into the spaces between the outside of the tube and the sandstone of the river bed cement mixture will be injected under pressure through holes in the lining, which subsequently will be closed by screwed plugs. As originally planned the tunnel was to have provided accommodation for passenger, vehicular and electric tramway traffic, but as a result of the Birkenhead Municipality's opposition, based on its fear of competition with its ferries, the provision for tramways has been omitted. At the same time the dimensions of the tunnel were not altered, and it would appear that the Parliamentary Committee which investigated the scheme deliberately intended to leave the possibilty open for the provision of a tramway track through the tunnel at a later date. As now to be constructed the tunnel will have two roadways through it, one above the other. The upper will accommodate heavy traffic, and the lower light, fast moving vehicles. Above the upper and on each side of the lower roadways ventilation ducts will be formed. The principal engineer to the scheme is Mr. Basil Mott, with whom Mr. J. A. Brodie is associated. Towards the total cost, estimated at £4,750,000, the Treasury will make a grant of £2,375,000. In addition, it will contribute half the annual cost of maintaining the road works. Powers have been given to levy tolls for a period of fifteen years.

The North British Engine Works.

ON October 2nd we announced that Barclay, Curle and Co., Ltd., of Glasgow, in association with Swan, Hunter and Wigham Richardson, Ltd., of Wallsend-on-Tyne, proposed to acquire the whole of the share capital of the North British Diesel Engine Works (1922), Ltd., of Whiteinch, Glasgow. This transaction has now been completed, and the Whiteinch works have been taken over by Messrs. Barclay, Curle, the North British Diesel Engine Works Company, Ltd., having gone into voluntary liquidation. The newly acquired works, with its extensive river frontage and 150-ton hammer-headed crane, is quite close to Barclay, Curle's Clydeholm shipyard at Whiteinch, and it is also not far from the firm's West Yard at Scotstoun and the company's Elderslie graving dock. It is the intention of the firm to call the combined works at Whiteinch the North British Engine Works, and engines of all kinds, including steam reciprocating engines, turbines, and marine oil engines of the four-cycle single-acting and the two-cycle double-acting type will be built at the works. The old Stobcross engine works of Barclay, Curle at Finnieston-street have been closed down, and the equipment will be gradually transferred to Whiteinch, while the machinery of the old boiler shops at Kelvinhaugh will be moved to the new works at a later date.

Launch of H.M.S. Rodney.

THE battleship Rodney was launched at the Cammell-Laird yard, Birkenhead, on Thursday of this week (December 17th), the ceremony being performed by H.R.H. Princess Mary, Viscountess Lascelles. The vessel was begun on December 28th, 1922, and will probably be ready for service in 1927. She was designed by Sir E. T. d'Eyncourt, the late Director of Naval Construction, and is a sister ship to the Nelson, which went afloat on the Tyne on September 3rd. These are the first battleships to be built subject to the restrictions as to displacement and armament which are imposed by the Washington Treaty. The displacement, exclusive of fuel and reserve feed water, is 35,000 tons, the length on the water line 702ft., the beam 106ft., and the mean draught 30ft. No details are known of the machinery, which is being manufactured by Cammell Laird and Co., but it is clear from the general design that the speed will be only moderate. The hull is flush-decked and the freeboard higher than that of earlier British battleships. The armament, it is understood, will consist of nine 16in. guns in triple barbettes, disposed forward on the centre line; twelve 6in. guns, twin mounted in light closed turrets, and a number of anti-aircraft pieces. Heavy armour protection is concentrated mainly in the vicinity of the big gun positions. A new form of control tower has been substituted for the usual tripod foremast. Owing to the distribution of the main armament, the machinery spaces have had to be retracted towards the stern and the funnel is therefore well abaft the 'midship line, thus imparting a very asymmetrical appearance to the ship. Bulge protection, it would appear, has been dispensed with, as Sir Philip Watts predicted would be the case.

Electricity Supply.

THREE Committees—namely, Finance, Technical Development and Works, and General Purposes—have now been established by the London and Home Counties Joint Electricity Authority. Steps have been taken by the authority to deal with the questions referred to it under the statutes and the London Order regarding the establishment of the sliding scale of prices to be charged for electricity by the London companies. It is hoped that it will be possible to put the sliding scale into operation in January next, in accordance with the desire expressed by the Electricity Commissioners. The authority has also taken in hand the immediate consideration of applications for orders to supply certain parts of the area, and is giving special attention to parliamentary applications for the ensuing session. It will be remembered that two Acts were passed by Parliament, having the effect of amalgamating four companies on the one hand and ten on the other into two separate groups. The London and Home Counties Electricity District Order, 1925, established a Joint Electricity Authority for the general supervision and development of about 1860 square miles, covering the counties of London and Middlesex, with parts of Essex, Herts., Bucks., Berks., Surrey and Kent, and the undertakings are to be finally taken over by the General Electricity Authority in 1971. Under the two Acts each company will be allowed to capitalise and distribute to the ordinary shareholders all reserves remaining after existing assets have been written down in accordance with the rates allowed by the Income Tax authorities.

Reviving the Shipbuilding Industry.

IN discussing means which might be taken to revive the shipbuilding industry, Mr. J. W. Kempster, managing director of Harland and Wolff's yard at Greenock, placed some interesting facts before the members of the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen at the annual dinner of the Association held in Glasgow on Saturday last. Broadly speaking, he said, there were 16,000,000 tons more shipping in the world whilst 20 to 25 per cent. less cargo had to be carried than before the war. Of the 16,000,000 tons, some 6,000,000 tons were laid up. The total amount of British shipping over twenty-five years of age was about 1,300,000 tons, and our present shipyards and marine engine works could replace that tonnage in about a year; or, expressed in another way, our yards and works had the capacity to rebuild the annual wastage of a mercantile fleet of nearly 40,000,000 tons, equal to double our own tonnage. The problem to be faced was a tremendous one. It was difficult to say exactly what tonnage was obsolete, but it would undoubtedly pay from the national point of view to put modern motor ships on trade routes now served by inefficient vessels if the capital were available to build them. This proposal pointed to the expending of Government guaranteed loans at special rates of interest under the Trades Facilities Act, to allow owners to build modern ships wherewith to replace obsolete tonnage. Another point not often appreciated was the effect of uncontrolled costs. In the building of a cargo boat direct wages only represented one-third of the total cost; the other two-thirds for materials, rates, taxes and power were affected by the high costs of shielded labour, which cost could not be controlled by the shipbuilder and the engineer. The Joint Committee of the Federation of Shipbuilding Employers and the trades unions was now considering the effect on the cost of shipbuilding of conditions outside the industry, and it remained to see what that effect was. If the report showed that it was futile to expect a revival of the marine engineering and shipbuilding trades whilst outside costs were so excessively high, then an industrial conference, representative of all interests, should be called by the Joint Committee to decide the best way of adjusting the balance between wages in the sheltered and unsheltered trades, so that foreign competition could be fairly met.

Locomotive Coal Trials on the Southern Railway.

By H. HOLCROFT.

THE coalfields of Great Britain are almost entirely served by three of the four large railway groups, and the locomotive coal used by each is obtained from its own territory. Except for a certain amount of Kentish coal drawn from its eastern extremity, the Southern Railway has to obtain the bulk of its coal from a distance, and therefore the choice of fuel presents a problem, involving such questions as class of coal and its cost at pithead, transport, stacking, &c. Hitherto the South-Western Section has depended on South Wales coal, as it is nearest at hand and can be transported by water across the Bristol Channel for the western end.

The Brighton Section has also used a good deal of Welsh coal, but the South-Eastern and Chatham has preferred the hard northern coals from Yorkshire, Nottinghamshire, North Wales, &c. The grouping of these railways has brought the coal question under review, and it has to be considered anew from many aspects, such developments as the electrification of suburban services, and the introduction of mechanical coaling plants being taken into account.

In order to obtain some data, a series of trials was arranged, the object being threefold, namely:—(1) To compare the results of using a typical South Wales and a Yorkshire coal; (2) to ascertain if any appreciable difference in the coal consumption is made by passing Welsh coal through a mechanical coaling plant; and (3), incidently, to observe the performance of the new 4–6–0 type engines of the "King Arthur" class.

The last, although of greatest engineering interest, was not a primary object; no special preparation or fitting of the engine was made, as more elaborate tests will be carried out at a later date. The results of the trials, however, are of some value, and with the kind permission of Mr. R. E. L. Maunsell, the Chief Mechanical Engineer of the Southern Railway, the writer is enabled to give details below.

The following arrangements were decided upon. In the first series of trials, three runs were made with the engine burning South Wales coal taken from the mechanical coaling plant at Nine Elms shed. In the second series, Welsh coal taken direct from a wagon was used, and in the third series of three runs, Yorkshire coal taken direct from a wagon was tried. The coal was carefully weighed before being placed on the tender, and after each trial the weight of the small amount of coal remaining was ascertained. A separate supply of coal in baskets was placed beside the engine in the shed for lighting up and steam raising, so that the coal on the tender was not used until the fireman started to build up his fire on leaving the shed. At the conclusion of each run, the contents of smoke-box, fire-box, and ashpan were thrown out and weighed.

The trains selected were the 11 a.m. Waterloo to Salisbury and the 2.27 p.m. Salisbury to Waterloo, the total distance run being 167½ miles for the outward and return journeys. These were both non-stop runs, and the times allowed for the 83¾ miles were 92 and 93 minutes respectively. The load was made up to twelve bogie coaches throughout the trials, and the trains were well filled with passengers, except in mid-weeks on the down journeys.

The weather remained fine and very favourable for trial purposes, and only on two or three days was the wind appreciable in velocity. Traffic conditions were also favourable, and signal checks were few except in approaching Waterloo on the up journeys; in these circumstances the results obtained were very consistent, as the many variables affecting locomotive performance were reduced to a minimum.

The locomotive selected was No. E 453, "King Arthur," the first of ten new 4–6–0 type engines built at the Southern Railway Company's Works at Eastleigh. Although nominally rebuilds of the Drummond four-cylinder 4–6–0 type engines with 6ft. diameter wheels, actually only the tenders remain of the original. The engines mainly follow in construction the "735" class with 6ft. 7in. diameter wheels designed by Mr. Urie, but the opportunity has been taken by Mr. Maunsell to embody some features introduced into his engines for the South-Eastern and Chatham Section, with most satisfactory results. The principal alterations to the previous class are an increase in boiler pressure from 180 lb. to 200 lb. per square inch, and a reduction in cylinder diameter from 22in. to 20½in., the stroke remaining at 28in., so that the tractive effort is practically unaltered. An enlargement of the steam and exhaust passages has been made, and the lap of the piston valves has been increased to 1¼in. and the travel in full gear to 6 7/16in. Other innovations are a larger diameter chimney, new smoke box arrangement, outside steam pipes, improved spring gear, a pump for maintaining the vacuum for the brake, and an exhaust steam injector. The superheater header and sight feed lubricator are of the S.E. and C. patterns. Although these details have not necessitated any large structural alterations to the previous design, they have produced an engine which is both exceptionally free steaming and free running.

Upon examination of the three series of runs, Trials Nos. 1 to 9, it was found that on the aggregate the consumption of Welsh coal was considerably increased when taken from the coaling plant, but the result was obviously affected by the abnormal consumption in the case of Trial No. 1, when the coal was unusually dusty. Furthermore the consumption of Yorkshire coal was rather less than had been anticipated, in view of its lesser calorific value as compared with the Welsh coal. It was therefore decided to repeat the first and third series, and accordingly a fourth series of runs took place using Welsh coal from the coaling plant, and a fifth series with a fresh supply of Yorkshire coal taken direct from wagons.

The conditions under which the extended trials took place were again highly favourable, the weather being exceptionally warm and fine. The loads, however, although still made up to twelve bogies, were nearly 10 per cent. heavier, owing to a part of the train being composed of newer and rather heavier coaches. On the other hand, steam heating of the train was no longer in operation. The results of the further series of runs fully confirmed the conclusions arrived at with the earlier tests, and the full details are given in Table I.

It should be observed that the ratio "pound of tender water per pound of coal" does not represent the full evaporative power of the coal, because about 10 per cent. of the exhaust steam is returned from the cylinders to the boiler through the exhaust injector. It does, however, include water used for wetting the coal and injector overflow losses. The latter were negligible in the case of Trials Nos. 1 to 9, but in the later trials, Nos. 10 to 15, the injector was rather troublesome, and a small but appreciable loss occurred at the overflow.

As the supplies of Welsh coal taken from the coaling plant and directly from the wagons both came from the same colliery, it is clear that the increased consumption in the former case can only be attributed to the large amount of dust formed, especially as the calorific value determined and the chemical analysis reveal that the fuel in the first series was, in this respect, the best used, as reference to Table II. will show.

Soft coal in passing through a coaling plant is first partially broken by being dropped from the wagon into the bin. It is then subjected to crushing by the weight of the superimposed coal in the bin, and, in addition, the lumps are further reduced by attrition in passing to the chute. Then there is the final fall on to the tender; hence, quite large quantities of dust are formed.

This dust is mainly lost in two ways while running. When thrown into the fire-box by the fireman, a percentage of it is caught up by the draught and carried through the tubes in a partially burnt state only. Some of this is ejected through the chimney, but a proportion is deposited in the bottom of the smoke-box. The second loss occurs from the rush of air

TABLE I.

Trial No.	Coal taken for steam raising.	Coal used from tender.	Total coal consumed.	Removed from smoke-box.	Removed from fire-box.	Removed from ash-pan.	Tare weight of twelve coaches.		Water used from tender.			Tender water per lb. of total coal consumed.	Total coal per engine mile.	Total ton-miles. Tr'n miles + light engine miles.	Total coal per 1000 ton-miles		Remarks.
							Outward journey.	Return journey.	Outward journey.	Return journey.	Total.						
							FIRST SERIES.—*Welsh Coal Taken from Coaling Plant.*										
	cwt.	cwt.	cwt.	lb.	lb.	lb.	tons.	tons.	galls.	galls.	galls.	lb.	lb.		lb.		
1	7	66	73	612	471	48	310	330	2194	2494	4688	5·75	47·4	75,917	107·6	Steam heating of train in operat'n	Coal abnormally dusty; steam raised from cold water
2	6	55	61	361	326	76	312	311	2466	2371	4837	7·09	39·6	74,493	91·7		
3	7	53	60	446	408	84	323	315	2409	2089	4498	6·71	39·0	75,749	88·7		
Mean	6·66	58	64·66	473	402	69	315	319	2356	2318	4674	6·47	42·0	75,386	96·0		
							SECOND SERIES.—*Welsh Coal Taken from a Wagon.*										
4	6	49	55	237	351	48	310	311	2470	2087	4557	7·42	35·7	74,331	82·9	Steam heating of train in operat'n	Steam raised from cold water
5	7	50	57	238	454	100	311	311	2379	2009	4388	6·88	37·0	74,409	85·8		
6	7	49	56	156	516	107	315	315	2218	1968	4186	6·70	36·4	74,666	84·1		
Mean	6·66	49·33	56	210	440	85	312	312	2356	2021	4377	7·00	36·3	74,469	84·3		
							THIRD SERIES.—*Yorkshire Coal Taken from a Wagon.*										
7	5	54	59	174	311	80	310	322	2282	2218	4500	6·79	38·5	75,247	87·8	Steam heating of train in operat'n	
8	4	54	58	130	299	92	310	310	2295	2149	4444	6·85	37·7	74,242	87·5		
9	5	55	60	160	315	70	311	310	2457	2024	4481	6·02	39·0	74,331	90·4		
Mean	4·66	54·33	59	155	308	81	310	314	2345	2130	4475	6·78	38·4	74,607	88·6		
							FOURTH SERIES.—*Welsh Coal Taken from Coaling Plant.*										
10	8	50	58	346	390	73	340	343	2359	1835	4194	6·46	37·6	79,523	81·7	No steam heating	Steam raised from cold water
11	8	49	57	412	426	78	336	339	2406	1872	4278	6·70	36·9	78,764	81·1		
12	8	48	56	366	441	74	332	350	2326	2122	4448	6·80	36·3	79,419	79·0		
Mean	8	49	57	375	419	75	336	344	2364	1943	4307	6·74	36·9	79,235	80·6		
							FIFTH SERIES.—*Yorkshire Coal Taken from a Wagon.*										
13	8	49	57	131	360	56	345	349	2446	2084	4530	7·10	36·9	80,439	79·3	No steam heating	Steam raised from cold water
14	7	45	52	138	242	63	329	335	2336	2006	4342	7·45	33·7	77,929	74·8		
15	8	45	53	112	206	30	344	323	2421	1981	4402	7·41	34·3	78,094	76·0		
Mean	7·66	46·33	54	127	269	50	339	336	2401	2024	4425	7·32	35·0	78,821	76·7		

while running carrying away the dust and fine particles from the exposed surface of the coal on the tender when dry. Frequent wetting of the coal by means of the hose lessens the losses, but to be effective so much water must be used that coal is shovelled wet into the furnace. A loss in efficiency then occurs by the water vapour carrying away heat through the chimney that should be used for producing steam in the boiler.

From an examination of Table I., it will be seen that the partially burnt fuel removed from the smoke-box is very much greater in the case of the first and fourth series when Welsh coal was taken from the coaling plant. For comparative purposes, however, the figures need to be placed on a percentage basis, and Table III. gives this information, the char being expressed as a ratio of the total fuel used. As a result of doing this, the smoke-box contents are found to be about 6 per cent. in the first and fourth series; 3¾ per cent. in the second; and only 2¼ per cent. for the third and fifth when Yorkshire coal was in use. The reason for this is that the Yorkshire coal is hard, and as it possesses definite cleavage planes, its tendency is rather to break up into small pieces during transport from colliery to engine depôt, than to form dust. The Welsh coal breaks irregularly, and being soft and friable, crumbles during transport, producing dust. When this coal is passed through a mechanical coaling plant, the percentage of dust is largely increased, and, as has been found by experiment, the efficiency of combustion is lowered.

TABLE II.—*Analyses of Coals and Smoke-box Char.*

Series	I.			II.			III.			IV.			V.		
Trial No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Coal	Welsh from coaling plant.			Welsh from wagon.			Yorkshire from wagon.			Welsh from coaling plant.			Yorkshire from wagon.		
Moisture, per cent.	0·8			1·0			2·6			0·9			2·4		
Ash, per cent.	6·7			9·5			5·5			7·8			9·3		
Volatile matter, per cent.	14·1			14·4			34·4			14·0			31·5		
Fixed carbon, per cent.	78·4			75·1			57·5			77·3			56·8		
	100·0			100·0			100·0			100·0			100·0		
Sulphur, per cent.	0·72			1·06			1·08			0·81			1·07		
Iron in ash, per cent.	5·00			6·20			10·60			5·70			6·30		
Calorific value, B.Th.U. per lb.	14,580			14,000			13,900			14,320			13,220		
Evaporative power (nominal), lb. water per lb. of coal, from and at 212 deg. Fah.	15·1			14·5			14·4			14·8			13·7		
Smoke-box char—															
Moisture, per cent.	1·2	1·1	1·3	1·2	1·2	1·4	1·0	1·2	0·9	1·2	1·5	1·0	0·8	0·7	0·7
Ash, per cent.	12·8	10·0	8·1	11·7	12·9	13·2	11·8	15·4	12·6	14·7	13·9	12·7	20·6	16·3	17·9
Volatile matter, per cent.	4·0	3·3	3·3	3·6	3·0	4·4	3·4	5·8	3·0	3·5	3·6	3·7	3·6	2·7	2·5
Fixed carbon, per cent.	82·0	85·6	87·3	83·5	82·9	81·0	83·8	77·6	83·5	80·6	81·0	82·6	75·0	80·3	78·9
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Calorific value, B.Th.U. per lb.	12,810	13,240	13,450	13,030	12,760	12,720	13,000	12,490	12,850	12,260	12,330	12,580	11,440	12,100	11,860

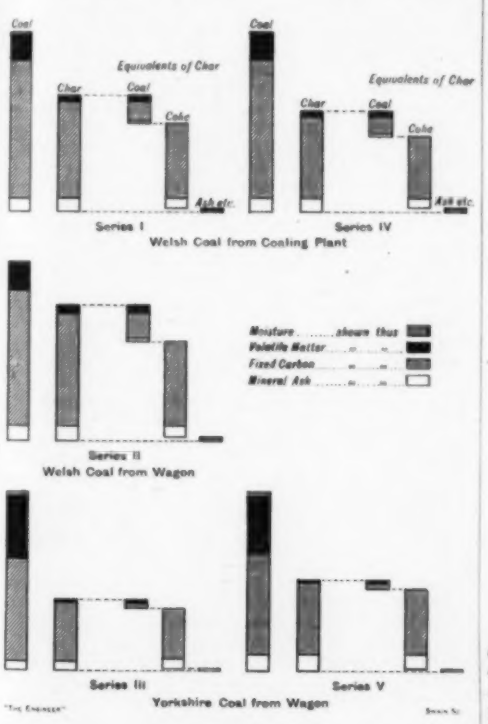


FIG. 1

TABLE III.

Series.	Average coal used per trip, cwt.	Contents of smoke-box, lb.	Contents as percentage of total coal.	Equivalent mixture of		
				Coal, lb.	Coke, lb.	Ash and moisture lb.
I.	64·66	473	6·57	114	351	8
II.	56	210	3·36	54	152	4
III.	59	155	2·35	16	136	3
IV.	57	375	5·87	96	270	9
V.	64	127	2·11	11	115	1

The analyses of smoke-box char in Table II. convey little as they stand. A little consideration will, however, show their significance. The smoke-box char is partly burnt fuel in various stages of decomposition, and a portion of it is derived from the small particles of coal which are swept off the fireman's shovel and carried through the flames to the tubes, and thence to the smoke-box. The other portion comes from the fuel bed, where the large lumps gradually break up or burn to a small size. The large pieces are stationary on the grate, and in between them the smaller pieces fill the interstices. These are agitated by the upward draught of incoming air from the ashpan, and the smaller they become, the higher they are lifted, until eventually they are reduced sufficiently to be carried away through the tubes. These portions are mainly coke—that is to say, coal with all the volatile matter distilled off. As the lumps of fuel reduce in size, owing to the fixed carbon being consumed, the non-combustible mineral matter left on the surface is either blown off and carried away or fuses together to form clinker. It is therefore evident that the smoke-box contents represent fuel in various stages of decomposition, ranging from raw coal to pure mineral ash, with coke as the intermediate stage.

Some insight into the smoke-box losses may be gained by expressing the char in terms of so much coal, coke and ash, its extreme and intermediate states. By this it is not to be inferred that the char is a mixture of the three states, but that it may, by means of its analysis, be equated to such a mixture. The proportions of coal, coke and ash will then express the degree of completeness of the combustion and the fuel loss. The method adopted is, first of all, to take the volatile constituent of the char and apportion to it sufficient fixed carbon and ash to represent the equivalent coal. The remaining fixed carbon is then given its proportion of ash to represent coke, and then a small balance of mineral ash is left over.

The diagram—Fig. 1—shows the proportions of the constituents of the original coal, and the resulting smoke-box char derived therefrom, the difference in height representing the fixed carbon and volatile matter abstracted by partial combustion. The smoke-box char is also shown in comparison with the proportions of coal, coke and ash equivalent to it in value. The diagram at once makes clear how much more completely the volatile constituent is reduced in the case of the Yorkshire coal.

It remains to compare the total contents of the smoke-box with its equivalents, and this is done in the right-hand columns of Table III. The quantity expressed as coke is an indication of the small fuel lifted from the grate, and the quantity as coal can be regarded as a measure of the loss that occurs at the moment of shovelling coal into the fire-box. In this respect, the average loss of Welsh coal in Series II. is about 3½ times as great as that of the Yorkshire coal in Series III. and V.; and when the Welsh coal is passed through the coaling plant, as in Series I. and IV., the loss is increased to eight or nine times. The loss as coke is likewise increased about 2½ times.

Direct comparison between the trials in Series I. and II. shows that on the average 8·66 cwt. more coal

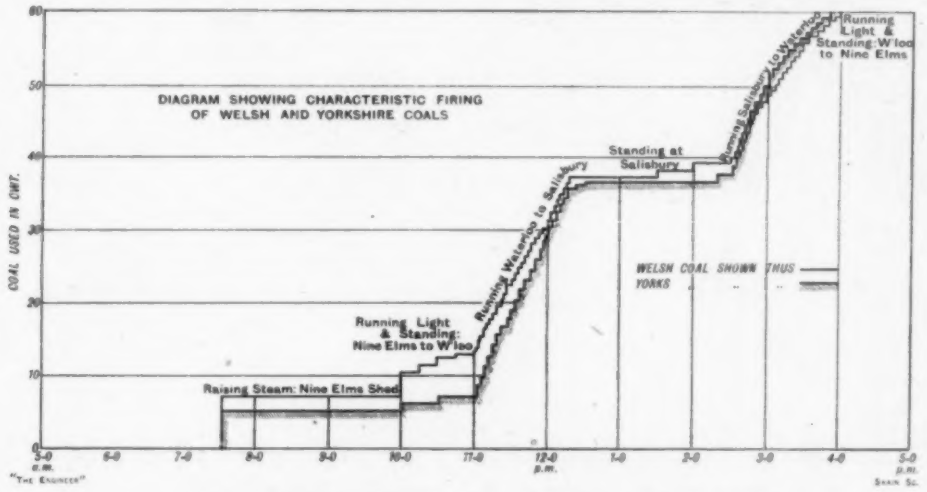


DIAGRAM SHOWING CHARACTERISTIC FIRING
OF WELSH AND YORKSHIRE COALS
COAL USED IN CWT.
Running Light & Standing: Nine Elms to Wloo
Raising Steam: Nine Elms Shed
Running Waterloo to Salisbury
Standing at Salisbury
Running Light & Standing: Wloo to Nine Elms
WELSH COAL SHOWN THUS
YORKS
"THE ENGINEER"

FIG. 2—RELATIVE CONSUMPTION OF YORKSHIRE AND WELSH COAL

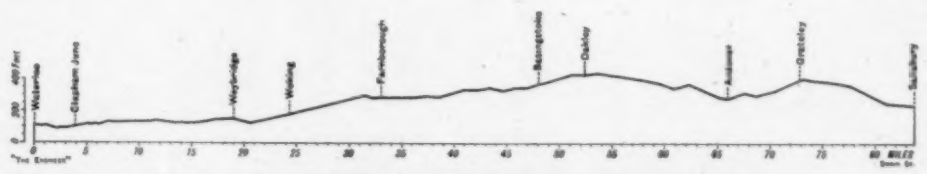


FIG. 3—PROFILE OF LINE WATERLOO-SALISBURY

is used per trip when taken from the coaling plant. This figure, however, is largely influenced by trial No. 1, in which the coal was abnormally dusty. The water used was also more, indicating a greater train resistance, but this is offset by the lower calorific value of the coal in Series II., as revealed by the large amount of fire-box and ashpan refuse in trials Nos. 5 and 6, and by the analysis in Table II. On the whole, therefore, it is fair to take the increased consumption as about 5 cwt., or 10 per cent. of the total. Of this 5 cwt., some 2½ cwt. is at once accounted for in the smoke-box contents, and the balance of the loss is to be looked for in the dust and cinders ejected from the chimney and in the coal dust blown off the tender by the air currents while running.

Comparing Series II. and III., the result favours the Welsh coal to the extent of about 3 cwt. per trip, under equal conditions. The Yorkshire coal can, however, successfully compete on account of its lower pit-head price, so that transportation cost, a varying factor, largely governs the situation. When the coal is passed through a coaling plant, the total cost of the Welsh coal is raised by the 10 per cent. increase in consumption. Yorkshire coal does not suffer from this drawback, owing to its hardness.

The cost of placing coal on the tender is another matter altogether, and a mechanical coaling plant is probably worth while, even if it occasions an increased coal consumption of 10 per cent. where Welsh coal is concerned.

The results of trials in Series IV. and V. have not been directly compared with the earlier results, as steam heating was not in use on the trains, and the coal consumptions are therefore lighter. A comparison of the later runs, however, generally bears out the results of the trials in Series I. and III., especially as regards the smoke-box contents.

In some respects the Yorkshire coal was the easier to use, and the fireman could take liberties with it that he could not take with the slower-burning Welsh. The characteristic burning of the two coals is illustrated by a diagram in Fig. 2, which affords a direct comparison, as a total of 60 cwt. was used in each case. The coal fired is shown on a time base, whilst the steps represent the rounds of firing throughout the day, and they gradually mount up until the whole 60 cwt. is accounted for. The diagram makes clear that more Welsh coal is required for building up a fire on leaving the shed, one reason being that the coal takes longer to get properly alight, and the other that a thicker fire is needed, both being due to the slower burning. Once started on the journey, the firing is lighter, and on approaching the end of the journey it may be relaxed earlier, as the fire burns down less rapidly. On the return journey the fire must be built up again in good time before starting. Less Yorkshire coal is required for making up the fire in the first instance, partly because it burns more rapidly and partly because a lighter and thinner fire suffices in running. In the early part of the journey the firing is heavier, and it cannot be relaxed so soon when nearing the end. On the other hand, little or no preparation is required for the return trip. About ten shovelfuls after backing on to the train are enough, and the fire can be further built up after starting away, as indicated by the rapid ascent of the line on the diagram. This eases off later, and finally the two lines coincide when the 60 cwt. is used up.

Broadly, it may be said that the consumption of Yorkshire coal is heavier than Welsh when the engine is in service, but the increased consumption is counterbalanced by the fact that less of it is used in the lighting up stage at the shed. This is further borne out by the figures in Table I., where the coal taken for lighting up is given.

The steaming of the engine was very good throughout the trials, irrespective of the coal used. On the whole, less damper opening was needed with the Yorkshire coal to maintain full pressure in the boiler.

The rate of combustion on the grate was quite moderate and averaged about 70 lb. per square foot of grate per hour, and the draught was correspondingly moderate. It is probable that with the higher rates of combustion and heavier draught usual in engines with smaller grate areas, the loss due to coal dust and fine particles would be more marked than has been found in the present instance.

Engine Performance.—In dealing with the engine performance it is necessary to consider what was actually accomplished in the way of train haulage, how this duty was carried out by the engine on the several trips, and, by comparing them, to arrive at the degree of efficiency attained.

The tare weight of the twelve coaches composing the trains on each up and down journey is given in Table I. In Trials Nos. 1 to 9 it will be noted that the trains were steam heated, the temperature of the atmosphere averaging 50 deg. Fah. A profile of the line is given in Fig. 3, and it will be seen that the ascent in the first few miles is small, and then, with several undulations, there is a gradual climb to Weybridge, after which the gradient stiffens through Woking and is almost continuous, becoming steeper as it approaches Basingstoke at 1 in 300, with a final 1 in 250 to the summit near Oakley. From there the line dips to Andover and then ascends again to Grateley, with a final sharp descent into Salisbury. The return journey is easier. After the stiff climb to Grateley there is the dip to Andover before a final ascent to the vicinity of Oakley, whence there is an almost unbroken downhill stretch to London.

The times allowed for the various sections of the journeys are set out in Table IV., together with the actual recorded times, which are given to the nearest fifteen seconds. It will be observed that in spite of permanent way speed restrictions and signal checks, the engine had no difficulty in keeping well inside the time allowance for the more arduous outward journey. Time lost by checks in the earlier part of the journey was regained by mile-a-minute running on the stiff pull from Weybridge up to Basingstoke. Beyond that point higher speeds, ranging from 70 to 80 miles per hour, were attained often and with ease.

In view of the superior performance on the outward journey, there is little to comment upon in the return journey. The engine was not pressed at all on the

TABLE IV.

Outward Journeys.—Waterloo to Salisbury.

	Distance between stations.	Length of sect'n.	Scheduled time for section.	Series I.			Series II.			Series III.			Series IV.			Series V.		
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Miles.	Miles.	Minutes.	Time in minutes between stations.														
Waterloo	0			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vauxhall	1·31			3½	3½	3½	3½	3½	4	3½	3½	3½	3½	3½	3½	3½	3½	3½
Clapham Junction	2·57			4½*	4½*	4½*	4½*	4½*	4½*	4½*	4½*	4*	3½	3½	3½	3½	3½	3½
		3·88	7	7½	7½	8	8	8½	8½	8½	8½	7½	7	7	6½	7½	7½	7½
Earlsfield	1·66			2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2	2½	4½*
Wimbledon	1·71			2	2½	2	2½	2½	2	2½	2½	2	2	2	1½	2	2	2½
Raynes Park	1·42			1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½
Malden	1·08			1½	1½	1½	1	1	1	1	1½	1½	1	1½	1½	1½	1	1½
Surbiton	2·26			2½	2½	2½	2½*	2½*	2½*	2½*	2½*	2½*	2½*	2½*	2½*	2½	2½	2½
Esher	2·37			2	2	2½	3½	3½	3½	3½	3½	3½	3	3½	3	2½	2	2½
Walton	2·69			2½	2½	2½	3	3	2½	3	2½	2½	3	2½	2½	2½	2½	2½
Weybridge	2·04			1½	2	2	2½	2½	2½	2½	2½	2	2½	2½	2½	2½	2	2
Byfleet	2·56			2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½
Woking	2·68			2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½
		20·47	21	20½	21½	21½	24½	23½	23½	24	23½	22½	22½	22½	22½	21	20½	23½
Brookwood	3·63			3½	3½	4	3½	4	3½	3½	3½	3½	4½	4	4	4	3½	4*
Farnborough	5·26			5½	6½	6	6	6	6	5½	5½	5½	5½	6	5½	6	6½	6½
Fleet	3·28			3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½
Winchfield	3·35			3	3½	3½	3	3½	3½	3½	3½	3	3½	3½	3	3½	3½	3½
Hook	2·35			2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½	2½
Basingstoke	5·61			5½	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½
		23·48	26	23½	24½	24½	24	24	24½	24	23½	23½	24½	24	23½	24½	24½	24½
Oakley	4·60			5½	5½	5½	5½	5½	5½	5½	5½	5	5½	5½	5	5½	5½	5
Overton	3·19			3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½
Whitchurch	3·61			3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½	3½
Hurstbourne	1·90			1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½
Andover	5·27			4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4
		18·57	19	18½	18½	18½	18½	18½	18½	18½	18½	17½	18½	17½	17½	17½	18	17
Grateley	6·28			5½	5½	6½	5½	5½	6	6	6	5½	6	6	5½	5½	5½	5½
Porton	5·50			5½	6	5½	5½	5½	6	5½	5½	5½	6	5½	6	6½*	5½	5½
Salisbury	5·46			5½	5	5½	5½	5½	5½	5½	5½	5½	5½	5½	5½	7	5½	5½
		17·34	19	17½	16½	17½	16½	17½	17½	17½	17½	16½	17½	17	17½	19	17	16½
Total		83·74	92	87	88½	90	91½	91½	92½	92	91½	87	90	88½	87	89½	87½	88½
	Net times			86½	87½	89½	90½	90½	91½	91	90½	86	89½	87½	86½	87½	87½	86

Permanent way speed restrictions or signal checks shown thus *.

Return Journeys.—Salisbury to Waterloo.

	Distance between stations.	Length of sect'n.	Scheduled time for section.	Series I.			Series II.			Series III.			Series IV.			Series V.		
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Miles.	Miles.	Minutes.	Time in minutes between stations.														
Salisbury	0			—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Porton	5·46			10½	9½	10	10	10½	10½	11	11	9½	9½	10½	10½	10½	10½	9½
Grateley	5·50			8½	7½	7½	7½	7½	8	8½	8	7½	7½	7½	8	7	7½	6½
Andover	6·28			5½	5½	5½	5½	5½	5½	6	5½	5½	5½	5½	5½	5½	5½	5½
		17·34	23	24½	22½	23	22½	24½	24	25½	24½	22½	22½	23	23½	22½	23½	22½
Hurstbourne	5·27			5½	5½	5½	4½	5	5	5½	5	4½	5	4½	4½	5	5	5
Whitchurch	1·90			2	2	1½	2	2	2	2½	2	2	2	2	2	2	2½	2½
Overton	3·61			4	4	4	3½	3½	4	4½	4	4	3½	3½	4	4	4	3½
Oakley	3·19			3½	3½	3½	3½	3½	3½	4	3½	3½	3½	3½	3½	3½	3½	3½
Basingstoke	4·60			4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½
		18·57	20	19½	19	18½	18	18½	19	21	18½	18½	18½	18½	19	19½	19½	19
Hook	5·61			4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	4½	5	5	5
Winchfield	2·35			2	2	2	2½	2½	2½	2	2	2½	2	2½	2½	2	2½	2½
Fleet	3·35			3	3	3	3	3	3	3	3	2½	3	3	3	3½	3	3
Farnborough	3·28			3	2½	3	3	2½	3½	2½	3	3	3	3	3½	3	3½	3½
Brookwood	5·26			4½	5	4½	4½	5	5½	4½	5	5	5	5½	5	5	4½	5
Woking	3·63			3	3	3½	3	3	3½	3	3½	3½	3½	3½	7†	3	3	3½
		23·48	22	20½	20½	20½	20½	20½	21½	20	20½	21	21	21½	25½	21½	21½	21½
Byfleet	2·68			2½	2½	2	2½	2½	2½	2½	2½	2	2	2	3½	2	2½	2½
Weybridge	2·56			2	2½	2½	2½	2½	2½	2	2½	2½	2½	2½	2⅝	2½	2	2
Walton	2·04			2	1½	1½	1½	1½	2	1½	1½	1½	1½	1½	2½*	1½	2	2
Esher	2·69			2½	2½	2½	2½*	2½*	2½	2½	2½	2½	2½	2½	2⅝	2½	2½	2½
Surbiton	2·37			2½*	2½*	2½*	3*	3*	3*	2½*	2½*	2½*	2½	2½	2½	2½	2½	2½
Malden	2·26			3½	3½	3½	3½	3½	3½	3½	3½	3½	2½*	2½	2½*	2	2	2½
Raynes Park	1·08			1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½
Wimbledon	1·42			1½	1½	1½	1½	1½	1½	1½	1½	1½	2	1½*	1½	1½	1½	1½
Earlsfield	1·71			1½	1½	2	2	2	2	2½	1½	2	2½	2½*	2	1½	1½	1½
Clapham Junction	1·66			2	1½	1½	1½	1½	2½*	1½	1½	1½	2	2½*	2½*	1½	1½	1½
		20·47	20	21	21	21	21½	22½	23½	22	21½	21½	21	21½	23½	18½	19½	19½
Vauxhall	2·57			4½*	4½*	5*	4½*	5½*	5½*	4½*	4½*	4½*	3½*	4½*	4½*	3½	4½*	3½*
Waterloo	1·31			4*	3½*	3*	6†	3½*	3½*	5½*	5½†	3	3½	5*	4*	2½*	4½*	5½†
		3·88	8	8½	8	8	10½	9½	8½	10	10½	7½	7½	9½	8½	6½	9	9½
Total		83·74	93	93½	91	91½	93½	95	96½	98½	96	91	90½	93½	99½	88½	93	92½
	Net times			92½	90	90½	89½	92½	94½	95½	92½	90	90	91	93	88½	92	90½

Permanent way speed restrictions or signal checks shown thus *.
Signal stops shown thus †.

sharp rise from Salisbury, as a little time lost on the first section could easily be regained afterwards without appreciably exceeding the scheduled speed. After passing Oakley, a small regulator opening was usually sufficient to maintain a mile-a-minute

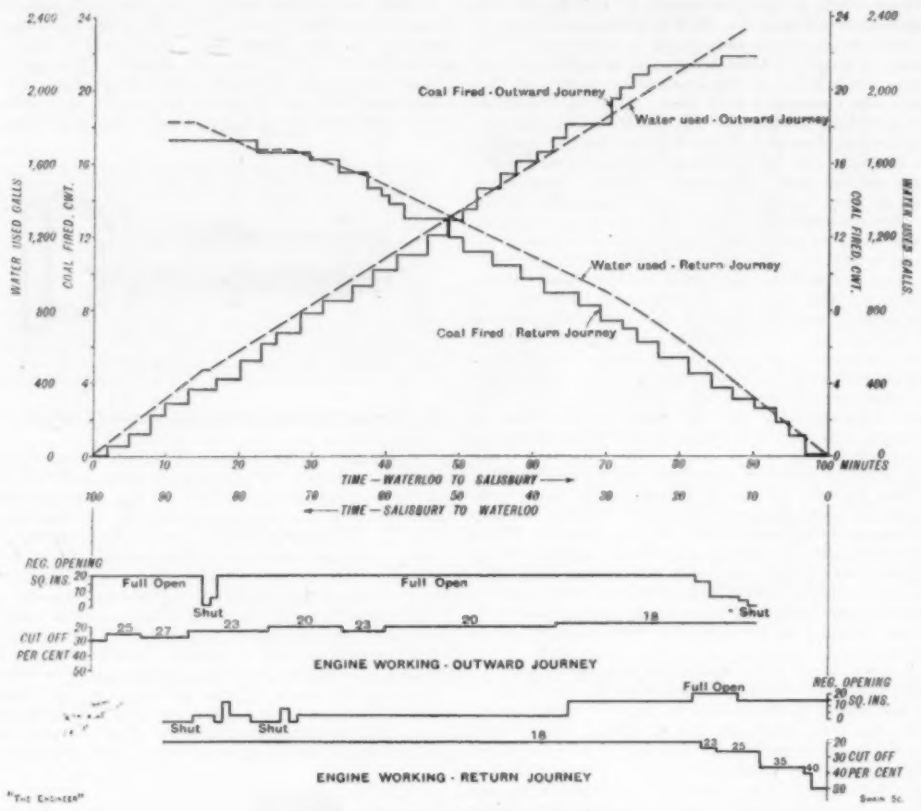


FIG. 4—ENGINE WORKING DIAGRAM

running to Clapham Junction. At or near that point, owing to the congested state of the line, signal checks invariably occurred, with the result that any time in hand was usually lost.

The easier work on the up journeys is reflected in

TABLE V.

	Into fire-box.	Out of fire-box.	Balance on grate.	Proportion of clinker and ash.	Coal used.
	cwt.	cwt.	cwt.	cwt.	cwt.
Fire kindling, live coals and firewood	0·50				
Coal taken from baskets	7·00				
Combustible consumed in steam raising		2·50		0·24	2·74
Balance on grate			5·00		
Coal for making up fire	5·36				
Combustible consumed in standing and light running		0·75		0·07	0·82
Balance on grate at start			9·61		
Coal fired on outward journey	25·70				
Combustible consumed on outward journey		25·78		2·43	28·21
Balance on grate at end			9·53		
Clinker removed		1·25			
Coal added for making up fire	2·24				
Combustible consumed in standing and light running		1·00		0·09	1·09
Balance on grate at start			9·52		
Coal fired on return journey	16·70				
Combustible consumed on return journey		21·77		2·05	23·82
Balance on grate at end			4·45		
Combustible consumed in light running and standing		0·75		0·07	0·82
Clinker and ash removed		3·70			
Balance on grate			nil		
Total clinker and ash				4·95	
Total coal used, including fire kindling	57·50	57·50			57·50

the figures for water consumption in Table I., but a more comprehensive view is obtained by the typical engine working diagram Fig. 4, in which coal fired, feed water used, regulator opening and cut-off of valve gear are all co-ordinated to time for the outward and return trips, the example selected being the record for Trial No. 10. The difference in coal is more marked than the water, but this is due to the fire being allowed to burn down when nearing London, so that there was only just enough fire on the grate on arrival to enable the engine to return to the shed and to be stabled under its own steam. The difference in coal and water consumption is accounted for by the fact that Salisbury Station is some 150ft. above Waterloo, and consequently an average of about 50 horse-power is needed to raise the train in the time taken, and this energy is given out on the return. Consequently there is a total difference of 100 horse-power between the average output for the up and down trips.

Reference to Fig. 4 shows that the engine was worked with a full regulator on the outward journey, and that the cut-off was mainly at 20 per cent. on the up grade and 18 per cent. after passing the summit near Oakley. In view of the high speed at which this was done and the weight of the train, it is evident that the mean effective pressure in the cylinders was nevertheless high, and the back pressure low, the result of ample port openings. On the return journey, the working was rather heavier for the first few miles of steep gradient, but once on the downward gradient, a small regulator opening and an 18 per cent. cut-off maintained a high speed.

The final step is to ascertain the weight of fuel expended in useful service on each trial, and at once a difficulty presents itself in the separation of "running" coal from that used in steam raising, in light engine running and while standing. In addition to the coal actually fired on the journey, a further amount of fuel is consumed when the fire is allowed to burn down towards the end of the journey. This is more pronounced on the return trips, because at the end of the outward journey sufficient fuel had to be left as a foundation for building up the fire for the return, whereas on the arrival back at Waterloo only enough was required to get the engine to the shed. An approximation of the weight of fuel on the grate may be made by carefully observing the relation of the brick arch and fire hole to the level of the fire, in order to judge its thickness, but this is not a very reliable method, especially as at the termination of the trip there is a preponderance of clinker and ash on the bars. A better way is to take the total coal consumed on each trial and deduct a fixed amount from each to cover steam raising, light running and standing, since these incidents were invariably the same on every occasion, except when steam had to be raised from cold water, in which case an additional allowance is made.

The estimation of this fixed amount of combustible —*i.e.*, coal less ash—for unproductive services requires care if it is to be trustworthy, and it should err, if anything, on the light side, to avoid any chance of the efficiency of the engine while in service being placed too high. The method adopted was to provide weighed baskets of coal beside the engine for steam-raising purposes. Then on several occasions the shovelfuls of coal taken from the tender by the fireman were carefully counted throughout the day. The total number of shovelfuls used for making up fires and while running gave the proportions of weight for each, since with a methodical fireman the average weight per shovelful varies but little in the aggregate. It then remains to draw up a balance sheet for each trip, giving input—*i.e.*, coal fired—as against output —*i.e.*, fuel consumed and refuse removed from the fire-box at the various stages. The unknown quantity is the allowance for unproductive services, and this when estimated should satisfy a number of conditions. It must close the balance sheet for each trip, it must be the same amount for each trip, and the weight of fire on the grate must agree with that observed to be present in the fire-box at the start and finish of each journey.

Careful consideration of all the figures and of the circumstances points to the unknown quantity as being at least 5 cwt. Accordingly, this fixed amount of combustible has been deducted from the total combustible used on each trip, with an additional 2 cwt. in those cases where steam was raised from cold water. The remainder is regarded as being consumed in running, and is divided in ratio to the water used for outward and return trips. A proportion of the total ash and clinker formed is then added to each of the amounts of combustible, and this gives the weight of coal used at the various stages.

In order to make the matter clear, an example of this method is given in the case of Trial No. 5 in Table V. The amount of fuel consumed while standing appears to be low, and is doubtless due to an absence of steam leaks and to the provision of a closely fitting ashpan and dampers.

When this process is applied to the other trials, the results set out in Table VI. are obtained. An examination of the figures indicates that the steam for train warming required about 3 lb. of coal per mile, and about 125 gallons of water per hour. Making this allowance, the average coal consumptions per mile are rather less in the outward journeys in Series I. and III., as compared with Series IV. and V., but on the return journey the reverse is the case. This is apparently due to the heavier stock hauled in the later trials; its frictional resistance was no more, but its greater weight made itself felt on the uphill journey, and it was easier running on the downhill. Hence, there is a more marked difference between the consumption of coal in the case of the outward and return journeys in the later trials, Series IV. and V.

Although the work performed by the engine varied only between narrow limits, the coal consumption expressed in pounds per thousand ton-miles ranged from 94·2 to 74·3 when running uphill and from 101·9 to 63·0 downhill. Apart from the engine and boiler efficiencies, much depends therefore on the character

TABLE VI.

Series.	Trial No.	Outward journey. Coal used.	Ton-miles.	Coal per train mile.	Coal per 1000 ton-miles.	Return journey. Coal used.	Ton-miles.	Coal per train mile.	Coal per 1000 ton-miles.	Class of coal used.	Remarks.
		cwt.		lb.	lb.	cwt.		lb.	lb.		
I.	1	30·89	39,766	41·4	94·2	35·14	38,440	47·2	101·9	South Wales	
	2	28·65	36,934	38·4	87·0	27·54	36,850	36·9	83·8		
	3	29·29	37,855	39·3	86·6	25·60	37,184	34·3	77·2		
II.	4	27·18	36,766	36·4	82·7	22·98	36,850	30·8	70·0	South Wales	Train steam heated
	5	28·21	36,850	37·8	85·9	23·82	36,850	31·9	72·4		
	6	25·80	37,184	34·6	77·7	22·93	37,184	30·7	69·0		
III.	7	27·50	36,766	36·9	83·7	26·70	37,771	35·8	79·2	Yorks.	
	8	27·46	36,766	36·8	83·6	25·74	36,766	34·5	78·4		
	9	30·25	36,850	40·5	92·0	24·96	36,766	33·4	76·1		
IV.	10	28·70	39,279	38·5	81·9	22·30	39,530	29·9	63·2	South Wales	
	11	29·29	38,944	39·3	84·3	22·79	39,195	31·6	65·2		
	12	26·67	38,608	35·8	77·3	24·38	40,116	32·7	68·0		Without steam heat
V.	13	27·01	39,698	36·2	76·3	23·01	40,032	30·8	64·4	Yorks.	
	14	25·42	38,356	34·1	74·3	21·81	38,860	29·3	63·0		
	15	26·56	39,614	35·6	75·0	21·74	37,855	29·1	64·5		

of the coal used, and one of a high calorific value is not necessarily the most economical.

Figures are often quoted to express the efficiency of an engine in pounds of coal per ton-mile, but unless the whole of the circumstances are known, they are valueless. Wide variations due to coal alone have been instanced above, speed is an important factor, and so is the ruling gradient. The trains themselves vary in resistance per ton of weight, heavy stock being easier to pull than an equal weight of light stock. The heating of trains by steam further handicaps the engine at times. All these factors have been dwelt upon in connection with the figures recorded here, but nothing has been mentioned as to the weight of the passengers and luggage carried. The figures for ton-miles are based upon the weight of the trains when empty, but the full loaded weight of engine and tender has been taken into account. The coal and water diminish as the journey proceeds, and this compensates to some extent for the load of passengers carried in the train.

At the end of the nineteenth century, the most economical engines were of the single-wheel type, and they consumed from 30 lb. to 35 lb. of coal per mile with loads of 150 to 200 tons. The latest design of engine of the Southern Railway has been found to average about 35 lb. per mile with loads of 310 to 350 tons at high speeds, and this is some further evidence of the progress of the steam locomotive, the efficiency of which has been nearly doubled in the last twenty-five years.

The Shipping, Engineering and Machinery Exhibition.

No. V.*

WE conclude below our account of the exhibits at the Shipping, Engineering and Machinery Exhibition at Olympia.

ALLEN-LIVERSIDGE, LTD.

The stand of Allen-Liversidge, Ltd., Victoria Station House, Westminster, S.W. 1, was devoted to demonstration work in welding, metal cutting, rivet heating, lead burning, brazing, soldering, paint burning and cable jointing. For welding purposes three types of plant were shown, viz., oxy-acetylene, using dissolved acetylene in cylinders, electric arc and electric resistance machines. We have, in the past, dealt with most of this apparatus, and thus need not enlarge upon it here ; but there were on the stand two more novel applications of the actylene blow-pipe. One of them was an air-acetylene system for doing such jobs as are commonly done with a gas blow-pipe and bellows.

As the name indicates, these blow-pipes burn a mixture of air and acetylene, and advantage is taken of the pressure of the stored acetylene to suck in the necessary air by means of an injector action. The acetylene jet and the air openings are so proportioned that the proper mixture is produced, and it is only necessary to have a cock in the acetylene supply pipe to regulate the flame to suit all ordinary requirements. The flame temperature is not, of course, so high as that of an oxy-acetylene blow-pipe, but at 2550 deg. it is much hotter than a coal gas flame. The merit of the system seems to us, however, to lie more in its handiness than in any other direction. A bottle of acetylene sufficient for several hours' work, together with the blow-pipe and tubing, can be slipped into a satchel little bigger than a lady's hand bag, and, in working, both the operator's hands are free, while he has not the distraction of working any bellows. An added advantage, as compared with a blow-lamp, for outdoor work, is the persistence of the flame. We understand, for instance, that it is possible keep one of these air-acetylene blow-pipes in operation on the outside of a railway train running at 40 miles per hour.

The second novel demonstration made on this stand was concerned with lead "burning" with an oxy-acetylene blow-pipe. It is, of course, obvious that such a blow-pipe might be used for the purpose, but the merits of the system do not appeal so forcibly until one has seen the process actually carried out. One of the chief merits of the oxygen-acetylene mixture for lead burning—that is to say, the autogenous welding of lead—is the high temperature of the flame, which is of the order of 4000 deg. Cent. The consequence is that the metal can be fused, at the spot where the joint is required, so quickly that the surrounding mass of metal is not appreciably heated by conduction. This feature is of great value in some industries, as in the maintenance of sulphuric acid chambers, as it enables repairs to be made without the adjacent lead sagging out of shape, or a hole being pierced accidentally and the fumes in the chamber escaping. At the Exhibition we tried our inexperienced hand with one of these blow-pipes, and found it possible to work on a piece of sheet lead only 4in. or 5in. square, without it becoming so hot at the edges that it could not be held in the hand. It must be admitted, however, that we found at the outset some difficulty in making a joint on account of the rapidity with which the flame melted the lead. The operator told us, nevertheless, that a man used to lead burning with hydrogen or coal gas can pick up the art of using an oxy-acetylene blow-pipe in half an hour or so.

A great merit of the system, as compared with the older processes, is the compactness of the plant, a feature which is illustrated in Fig. 74, which represents the gear necessary for a normal day's work. It will be noticed that the bottles of acetylene and oxygen are quite small, as the gases can be stored at high pressures and are required at only 10 lb. per square inch at the blow-pipe. The advantages of this characteristic of the system for outdoor work, especially at a height, need no emphasis.

In Figs. 75 and 76 we illustrate two typical classes of work carried out with these blow-pipes, and Fig. 75 is specially interesting as it indicates the extent to which metal can be built up for reinforcement by this process. In this case, the branch pipe was tack-welded in place, and then the building up of the fillet to form was carried out in one operation—that is to say, the whole depth of metal was added in one thickness. Fig. 76 represents one form of joint, made in sheet and plate lead, by this process, and shows what a neat finish can be produced by an expert hand. The joint, it will be noticed, is reinforced by a multiple building-up process, on account of the thickness of the metal. We understand that a man using one of these blow-pipes can turn out about half as much more work than would be the case if he were working with coal gas.

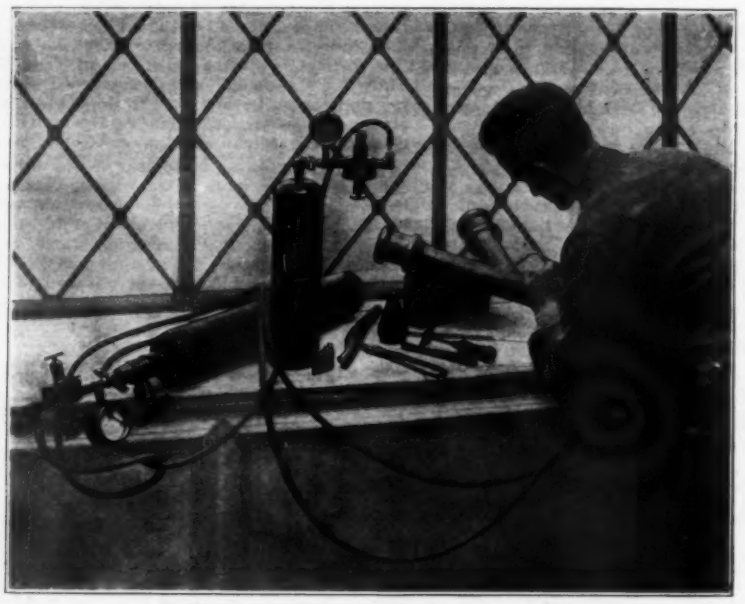


FIG. 74—LEAD BURNING IN OPERATION ON A BRANCH PIPE

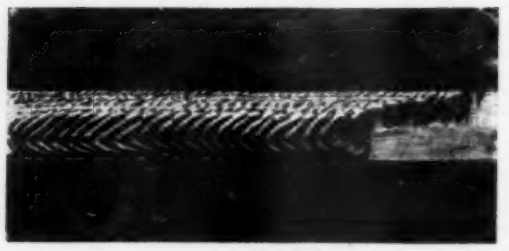


FIG. 76—FLAT LAPPED SEAM IN PLATE LEAD

THE KANGO COMPANY, LTD.

The Kango Company, Ltd., of 78, Petty France, Westminster, exhibited a number of the electrically operated hand hammers which we described in detail in our issue of June 26th last. These tools are intended for comparatively light work, such as chipping, stone dressing and punching holes in brickwork, and have a very ingenious mechanism invented by Professor Goldschmidt.

In external appearance—as will be seen from Fig. 77—the tool looks much like a pneumatic hammer. Inside the casing, towards the handle end, there is a small electric motor, with its spindle arranged axially along the casing, which runs at about 10,000 revolutions per minute. The spindle passes through a stuffing-box in a diaphragm and is connected with an extension by means of a sliding joint. At the end of the extension there is a small bevel pinion, which meshes with two larger wheels, one on either side. These wheels are journalled in a casting supported on the end of the spindle extension, but are not otherwise attached to the casing. They are deliberately made out of balance and the heavy sides are arranged to face one another. The result is that as the wheels rotate they produce a rapid longitudinal vibratory movement, but do not vibrate transversely, as the reactions of the weights neutralise one another sideways. These longitudinal vibrations are, of course, transmitted to the casting, which is formed as a striking piece to deliver blows on the tool. There is, however, a "transmitter" between the striker and the tool, and it is fixed in a flexible diaphragm, so that the gear case can be hermetically sealed and filled with lubricant.

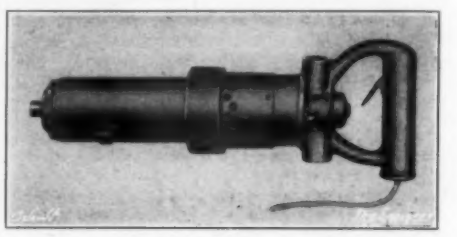


FIG. 77—ELECTRICALLY-OPERATED HAMMER—KANGO CO.

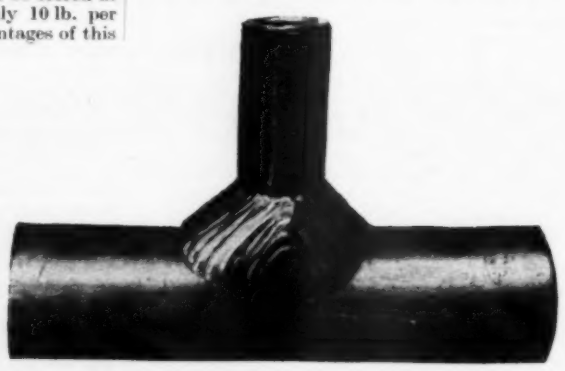


FIG. 75—BRANCH JOINT

The blows given by these hammers are comparatively light, but they will do a large amount of work on account of their rapidity. The current consumption of the motor is quite small, and can safely be taken from an ordinary lamp socket. The motors are wound for most standard voltages, and can be used on either alternating or direct current circuits.

HAKOL, LTD.

A gas generator of rather unusual form, which was exhibited by Hakol, Ltd., of Melbourne-place, Aldwych, London, W.C. 2, is illustrated by the line drawing, Fig 78. It is intended for producing gas for running engines, firing boilers or heating furnaces, from the crude residual of fuel oils. In it the oil is burned to such an extent as to provide the heat necessary for breaking up the remainder into a fixed gas, which can be distributed by piping just as can ordinary town's gas.

The apparatus comprises a simple cylindrical casing, lined with fire-bricks, into which the oil is injected under the influence of a comparatively low head by gravitation. A supply of air is also introduced by a fan, and both the oil and air are preheated by being circulated round cavities in the front cover of the

* No. IV. appeared December 11th.

generator chamber. The heat of combustion of a fraction of the oil maintains the brickwork at a bright red heat, and the heat radiated from the brickwork "cracks" the remainder of the oil, which is discharged as a permanent gas, at a temperature of about 700 deg. Cent. For this reason it is obviously desirable that the gas should be immediately used if its sensible heat will be of any value, and in such cases, we are told, as much as 92 per cent. of the theoretical heat value of the fuel will be realised. If the gas is allowed to cool down to normal temperature, the efficiency is put at about 89 per cent. By comparison with some producer gases the gas made by this apparatus has a high calorific value, as the proportion of nitrogen in its composition is low, and it generally ranges from 157 up to 260 B.Th.U. per cubic foot.

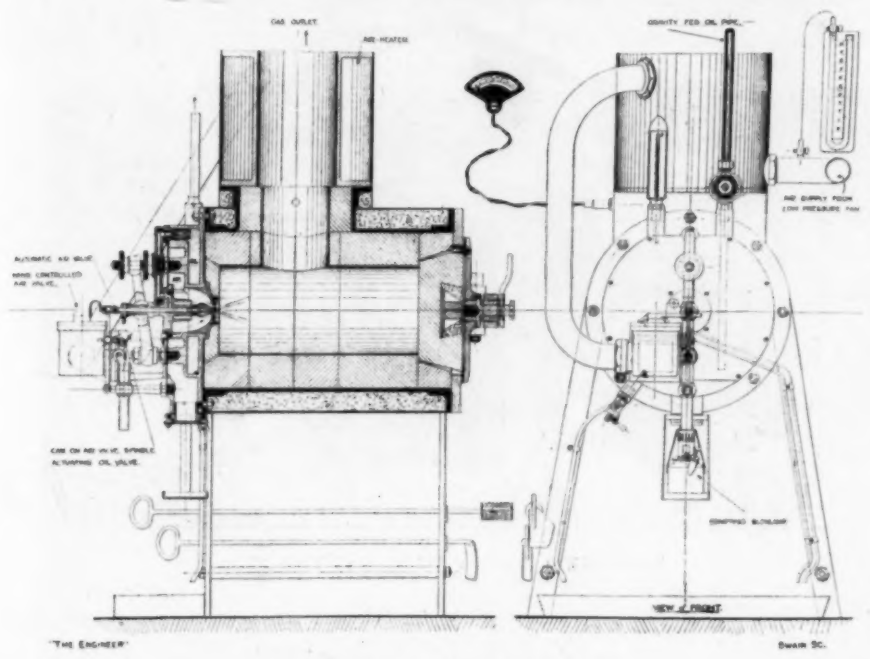


FIG. 78—OIL-GAS PRODUCER—HAKOL, LTD.

Some care has been taken in the designing of this apparatus to make it as convenient as possible from the point of view of overhauls, and the various parts are so arranged that it is almost impossible to put them together in the wrong positions. The burner gear includes a simple automatic device which regulates the supply of oil according to the demands on the plant which it supplies.

PNEUMATIC PLATE TIGHTENER SALES COMPANY, LTD.

The Hallet patented pneumatic plate tightening machine was shown on the stand of Pneumatic Plate Tightener Sales Company, Ltd., of Brownlow House, 50-51, High Holborn, W.C. 2. For purpose of demonstration three plates ¾in. thick and two ⅝in. plates were placed in position and could be drawn together by different machines, compressed air at a pressure of 100 lb. per square inch being supplied by an electrically driven Reavell compressor. An illustration of the machine is reproduced in Fig. 79. It consists essentially of two opposed air-operated pistons which work two sets of double toggle gear. The draw-bar, to which is attached an automatic air-controlled chuck, is fixed to the upper toggle seat, whilst an adjustable stand is also provided to lengthen or shorten the stroke of the draw-bar. A plain button-headed bolt with a key slot is employed instead of the ordinary screwed service bolt, and a quarter turn of the air control handle suffices to grip the button head of the bolt and so to support the weight of the machine;

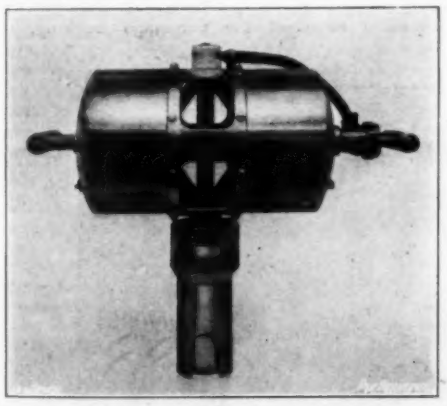


FIG. 79—PNEUMATIC PLATE TIGHTENER

with plates from ½in. to 1in. in thickness, and to these machines a new and larger type of tool specially constructed for heavy bridge work has recently been added. It has 8½in. cylinders with 110 cubic inch capacity, and will take plates up to 1¼in. in thickness, ⅞in. diameter or 1in. diameter bolts being used. It weighs 45 lb. and is designed to exert a total closing pressure of about 40,000 lb.

JAMES GORDON AND CO., LTD.

The Copes feed-water regulator, which was exhibited by James Gordon and Co., of Windsor House, Kingsway, London, W.C. 2, is so familiar to our readers that we need not here describe it at any great length; but the one shown was novel to the extent that an audible and visible alarm has been added to the original model.

As will be seen from Fig. 80, the regulator operates on the external thermostatic principle. An inclined brass tube is mounted on the boiler just about the normal water level, and is connected with the steam and water spaces in the same manner as a gauge glass. The expansion and contraction of the brass tube, as it is exposed, more or less, to the heat of the steam, is transmitted through a system of levers to a special check valve in the feed-water pipe. In this way the rate of feed is automatically regulated according to the demands made on the boiler and the water level is kept approximately constant. A slight lag in the action does, however, take place and is taken advantage of to provide a storage of heat in the boiler. Thus, when the load goes off, the water level rises slightly and when the load comes on again this hot water is ready to help the boiler in generating the extra steam demanded.

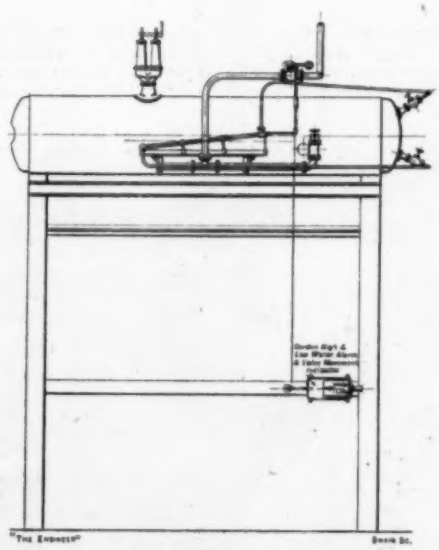


FIG. 80—FEED-WATER REGULATOR—GORDON

Although the thermostat provides a powerful force for operating the check valve, which is only limited by the buckling strength of the brass tube, it is conceivable that the valve might jam and then there would be a danger of the boiler overfilling or running dry if the stoker were inattentive. For this reason the new alarm has been added. It is operated by a rod depending from the thermostat and a sliding joint is provided in the connection to the check valve, so that the valve can be pushed open, but the lower rod can drop, with the thermostat, if the valve jams open. The alarm has a simple pair of electrical contacts and a swinging arm arranged in a dust-proof box. The arm is connected with the thermostat and completes either one or the other of two low-voltage circuits at the extreme ranges of high and low water. The current is used to sound a hooter and to light up appropriate signs. A pilot light in the box is used to show that the electricity supply has not failed.

AUTO-KLEAN STRAINERS, LTD.

Among the series of strainers for marine and industrial use exhibited on the stand of Auto-Klean Strainers, Ltd., of 1A, New London-street, E.C. 3, we noted a large 5in. bore strainer similar to that recently fitted on the Orient liner Oronsay. We reproduce a view of this particular type of strainer in Fig. 81. It will be recalled that the Auto-Klean strainer was first exhibited at the Shipping, Engineering and Machinery Exhibition which was held at Olympia in September, 1924, and in our issue of September 21st for that year an account of it was given. The straining medium consists of a cartridge built up of series of sheet metal discs—see Fig. 82—which are interleaved by thin washers and are furnished with cleaning blades. The cartridge can be rotated by means of an outside handle, and the dirt is scraped off and is carried clear of the cartridge. The 5in. marine type strainer referred to is provided with a specially large dirt deposit chamber, and it is designed to deal with 10 tons of heavy fuel oil per hour. On the Oronsay one of these strainers was placed in the after boiler-room on the suction side of an oil fuel pump which served three double-ended and two single-ended boilers.

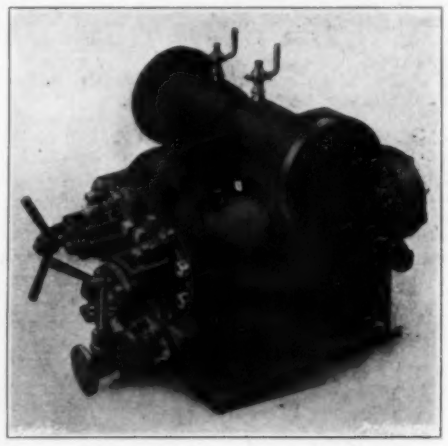


FIG. 81—5in. OIL FUEL STRAINER—AUTO-KLEAN

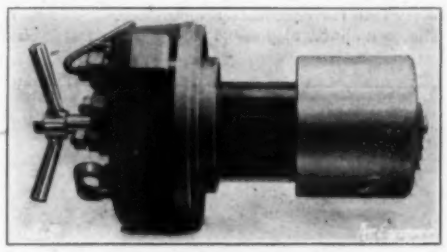


FIG. 82—CONVERTED GAUZE STRAINER

This strainer has two cartridges, each of which is designed to deal with the full duty of 10 tons of oil fuel per hour. They are placed in a common chamber and can be used in series, which greatly increases the period between successive cleaning operations. In the improbable event of one cartridge being damaged the other can take the full load throughout the voyage. The aim of the designers is, however, we learn, to eliminate one cartridge and to use a single cartridge only, with a corresponding reduction in the size of the strainer housing and the cost of the apparatus. The improved type of strainer we have described is stated to be not more costly than the ordinary gauze type. In Fig. 82 we illustrate a new pattern strainer which has been designed to convert existing marine type gauze strainers to the Auto-Klean principle of working. The cartridge with its turning handle is shown together with the end sump bowl. When in

position the cartridge is protected by a light steel cover or skirt. Strainers of the Auto-Klean type have also been adapted for use both for petrol and lubricating oil on industrial oil engines, motor cars and aircraft engines.

CRANKLESS ENGINES, LTD.

Considerable interest was shown at Olympia in the eight-cylinder crankless petrol engine, a sectional working example of which was displayed on the stand of Crankless Engines, Ltd., of 20, Grosvenor-gardens, London, S.W. 1. A general view of this engine, which was sectioned in order to show the working parts, is reproduced in Fig. 83. It is of a type well suited for launch, automobile, or electric lighting work, which requires a prime mover with a very constant turning moment. There are eight cylinders, each with a diameter of 3·31in. and a stroke of 3·51in., and they operate on the four-stroke cycle, a firing stroke being obtained at every 90 deg. of shaft rotation. On a brake test the engine has, we are informed, developed 64 brake horse-power at a speed of 3000 revolutions per minute. Illustration Fig. 83 serves to indicate the cylinder grouping, while Fig. 84 shows two of the main pistons and the manner of their engagement with the swashplate or slant. It will be seen that the pistons are connected together by means of a rigid steel yoke carrying the Michell pads which embrace the periphery of the slant. The actual pistons are made from an aluminium alloy, and the complete weight of the double unit with connecting yoke is only 7·2 lb. This weight, which is equivalent to a weight of 0·4 lb. per square inch of piston area, compares very favourably, we are informed, with the corresponding figure for ordinary automobile engines.

The swashplate or slant is of forged steel and has a diameter of 10in., with a thickness of 2in. It weighs 40 lb. The two faces are formed at an angle of 22½ deg. with a plane at right angles to the axis of the shaft. In order that dynamic balance may be maintained a definite relation is established between the masses of the oscillating parts and the mass of the slant, which may be easily calculated, no balancing by trial being necessary. The valve mechanism is of the ordinary push-rod and tappet-operated type, as is shown in Fig. 83. It is actuated by two vertical cam shafts. The exhaust and inlet valves are mounted in the heads of the cylinders and open directly into the combustion chambers.

The cam shafts also serve to drive the water circulating pump, the ignition spark distribution mechanism and the lubricating oil pumps, one arranged at the upper and the other at the lower end of the cam shaft. The pressure pump supplies oil at 5 lb. per square inch, which is supplied to the main bearings, the cam shaft bearings and to the surface of the slant.

Another interesting exhibit shown on the same stand was the three-cylinder crankless air compressor illustrated in Fig. 86. This machine is a single-ended air-cooled compressor with three cylinders of 3½in. bore and 3⅜in. stroke. It is designed for electric driving at a maximum speed of 1000 revolutions per minute. The valve ports are designed for a mean working pressure of 80 lb. per square inch, and at this pressure and a normal speed of 975 revolutions per minute the compressor absorbs about 11 brake horse-power. The displaced volume of the piston is 62·5 cubic feet per minute at 1000 revolutions and the mode of piston engagement with the slant is shown in Fig. 85. The suction and delivery of the air is effected by a single rotary valve which is concentric with the shaft and turns with it. It will be seen from Fig. 86 that the cylinders are provided with light fins, which, when running, are covered with a light cowl through which air is driven by the centrifugal fan mounted on the end of the compressor spindle.

Broom and Wade, Ltd., of High Wycombe, also showed a working example of a crankless two-stage compressor built under the patents of Crankless Engines, Ltd. An illustration of this machine is reproduced in Fig. 87. It is an eight-cylinder compressor arranged for two-stage working, six of the cylinders being low pressure and two high pressure. The principle of operation is similar to that we have already described, and in the view given

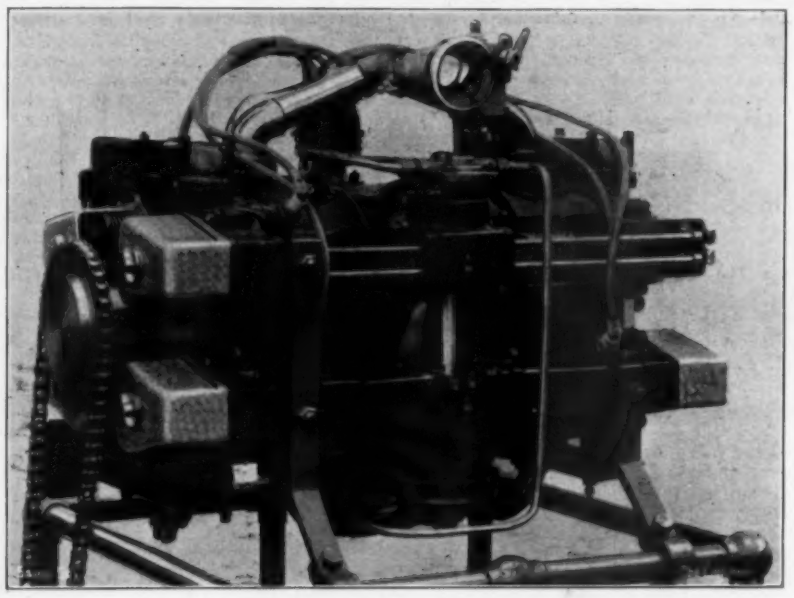


FIG. 83—EIGHT CYLINDER CRANKLESS PETROL ENGINE

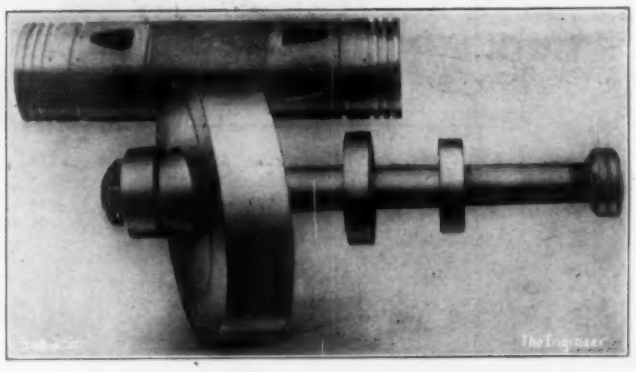


FIG. 84—ENGINE PISTONS AND SLANT

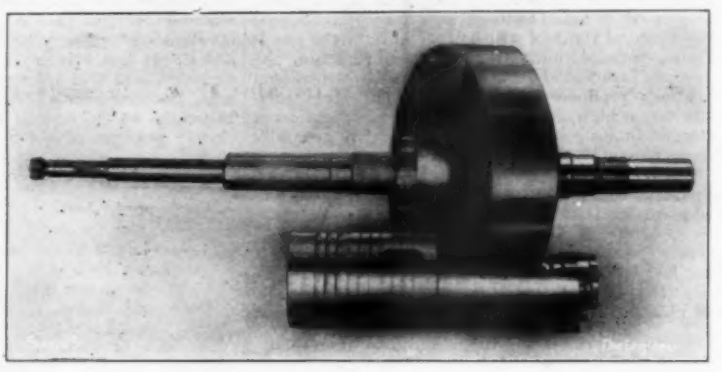


FIG. 85—COMPRESSOR PISTON AND SLANT

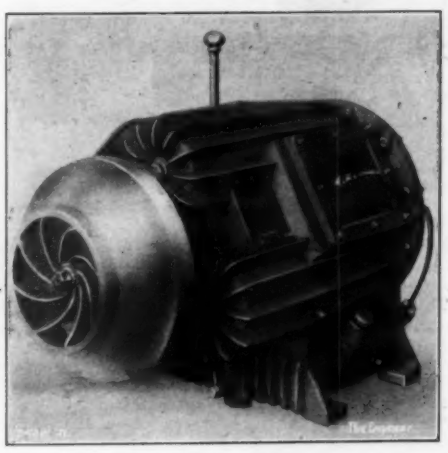


FIG. 86—SMALL COMPRESSOR

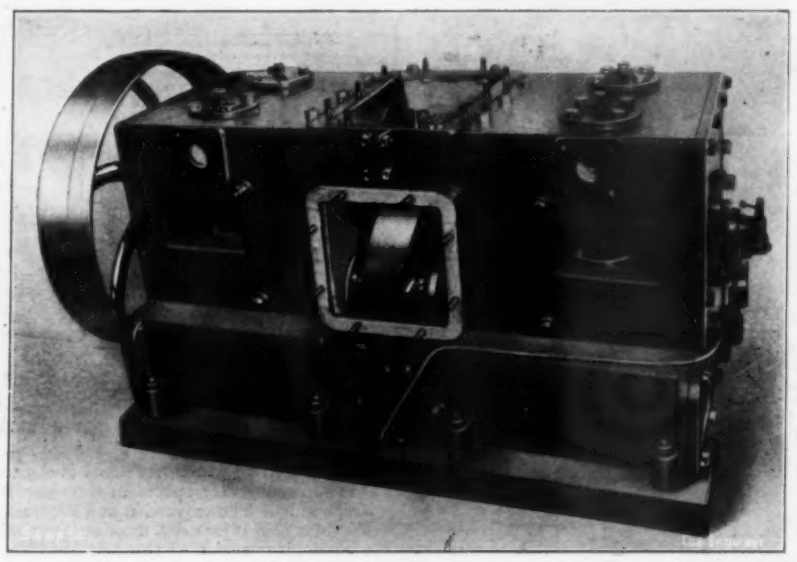


FIG. 87—CRANKLESS AIR COMPRESSOR—BROOM AND WADE

the inspection doors have been removed in order to show the slant and the piston unit with the Michell pads. The lubricating pump and oil connections are also seen. This compressor was built for an output of 300 cubic feet of air per minute delivered at a pressure of 150 lb. per square inch. It is designed to run at a normal speed of 750 revolutions per minute.

THOS. FIRTH AND SONS, LTD.

The design of stand adopted by Thos. Firth and Sons, Ltd., of Sheffield, was particularly appropriate and effective. The centre of the stand was made to represent a large ingot of Firth's "Staybrite" silver steel supported on supports of the same material. The walls of the ingot were highly polished, and over them ran a continuous film of water throughout the duration of the Exhibition. This in itself provided a convincing illustration of the non-corrosive properties of the steel. Displayed on the stand were a wide range of tools, industrial fittings and household utensils made of "Staybrite" silver steel, which, it appears, combines ductility with corrosion-resisting properties and at the same time lends itself to brazing, welding, soldering, or riveting without trouble. Several examples of stainless steel turbine blades were exhibited, as well as cold-drawn tubes made from "Staybrite" steel, whilst non-corroded samples were exhibited in various corrosive liquids. The larger exhibits included examples of the firm's cast steel turbine wheels with stainless steel blades cast in position in the wheel. Another prominent exhibit was a large cast steel dredger bucket with a manganese steel lip designed to resist wear and abrasion. Some stainless steel barrels, manufactured by the Steel Barrel Company, Ltd., of Uxbridge, were also displayed. They are widely used, we understand, for the transport of beer, chemical and commercial liquids, especially in tropical climates. An exhibit by Mr. J. S. Peress, of Byfleet, attracted a considerable amount of attention. It was a deep-water diving suit made from Firth's rustless steel. The suit as shown was not complete, but we understand from the inventor that the important joints have been tested to pressures corresponding to a working depth of 650ft. of water. As shown the total weight of the suit was about 550 lb., and it is claimed that the steel is superior to the aluminium alloys which have been used in other suits. One of the specialities is the ball joint for the legs and arms, which is made with a rubber diaphragm filled with water or other liquid so as to form a fluid cushion. It enables the joint to take up any new position without friction, such as would undoubtedly occur were balls, rollers, or other flexible means employed. Another type of joint based on the same principle without rubber has also been satisfactorily experimented with and has withstood test pressures up to 700 lb. per square inch.

J. B. RUDKIN.

Some exhibits of interest to engineers who are dealing with the development of electrical distribution in rural districts, were shown by Mr. J. B. Rudkin, of Albion House, 59, New Oxford-street, the London representative of Sprecher and Schuh, of Arrau, Switzerland. Among these exhibits was a three-pole 45,000-volt outdoor type overhead transmission line sectioning switch—as shown in Fig. 88—combined with high-tension expulsion type fuses. The metal parts are fixed to the insulators without the use of cement, which the makers contend is a source of danger, as in consequence of atmospheric variations, this cement is caused to expand and to burst the insulators, with the result that the supply is interrupted. The line sectioning switch exhibited is constructed for mounting on the flat top of an iron transmission tower, access to the fuses being obtained from a platform. The switch is operated by means of a lever in a cast iron case, which is provided with a lock and key. A simple interlock insures that the switch must be completely moved to its "on" or "off" position.

FIG. 90—TRANSMISSION LINE MAST WITH TRANSFORMER

There was also a three-pole 12,000 volt automatic overload outdoor type line sectioning switch—see Fig. 89—fitted with a direct-acting overload time limit release and loose handle attachment. The releases are protected against the weather by metal hoods. Another exhibit was a mast transformer station—as shown in Fig. 90. This forms a cheap and self-contained unit for supplying electrical energy to small isolated consumers. Besides the transformer there are choke coils, primary and secondary fuses, and, if required, surge protecting gear can be fitted. A three-pole

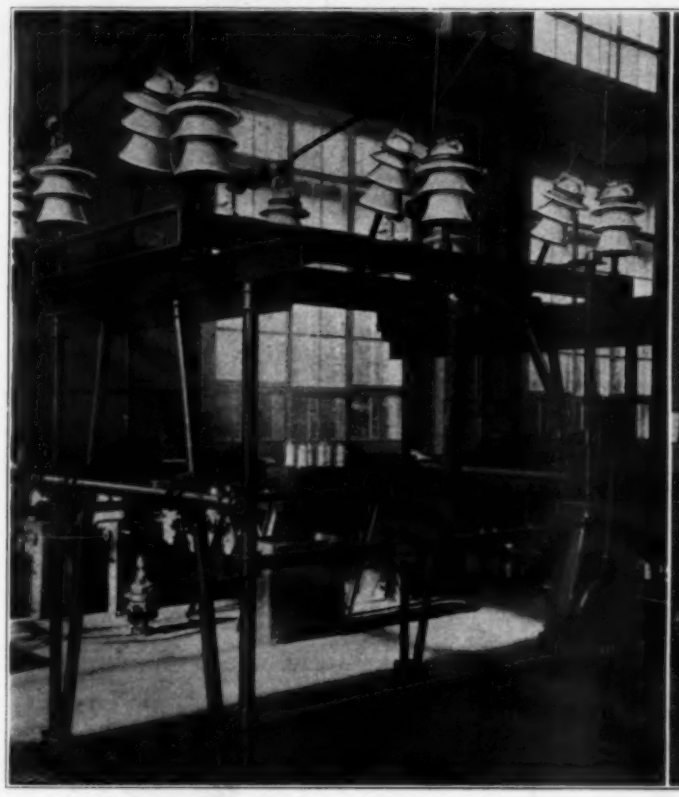


FIG. 88—45,000-VOLT LINE SECTIONING SWITCH—RUDKIN

FIG. 89—12,000-VOLT LINE SECTIONING SWITCH—RUDKIN

12,000-volt oil immersed circuit breaker exhibited has been designed to meet all contingencies of service, and it is operated by means of a hand wheel. All the active switch parts are fixed to a cast iron cover, which practically forms the base plate for the entire mechanism. The overload time limit releases are mounted directly on top of the terminals of the switch, which is of strong construction, has a long break and a high breaking capacity. Knife switches for mounting of switchboards and with back connection contact studs were also shown. These switches are also constructed on very robust lines, and all parts are nickelled to avoid tarnishing. They are made in sizes up to 1000 ampères capacity. There were other knife switches for mounting at the back of panels, and constructed without porcelain insulating material, the contacts being fixed mechanically to iron bars surrounded by insulating material. These switches, which are made in sizes up to 4000 ampères, are claimed to be specially well suited for factory or mining use, and also for use on power station switchboards.

A. HARPER, SONS AND BEAN, LTD.

On the stand of A. Harper, Sons and Bean, Ltd., of Dudley, applications were exhibited of the new Hele-Shaw-Beacham variable hydraulic transmission system. This gear is a development of the original design patented by Dr. Hele-Shaw in 1908, and embodies improvements suggested by Mr. T. E. Beacham, intended to increase the efficiency, eliminate the humming noise that formerly was present, and permit the gear to be built without restriction as to size.

The gear consists of two units, a variable stroke pump and a constant stroke hydraulic motor. The pump drives the motor by supplying oil to it, and by varying the pump stroke the pressure of the oil, and consequently the torque applied to the driven shaft, can be varied. If the regulation of the pump stroke is continued beyond the point of no discharge, the flow of the fluid is reversed, so that the gear is not only a continuously variable, but a reversing one.

The motor, shown in section in Fig. 92, consists of a casing enclosing a rotating element, within which five cylinders are formed. The pistons of these cylinders by means of short spherical headed rods drive against a fixed crank pin round which the palms of the connecting-rods are arranged in a closely spaced manner. The rotating element is attached to a flange on the driven shaft, and close to this flange is supported on a ball bearing mounted on a disc which is keyed to the fixed crank pin concentrically with the driven shaft. At the other end, the

rotating element is supported on a pair of roller bearings mounted on a fixed cylinder provided with ports and constituting a valve for the admission and exhaust of the working fluid. The oil enters the interior of the valve at A and flows to the cylinders when the port B is uncovered by the mouth of the passage C. On the opposite side of the cylindrical valve a port similar to C is provided for the exhaust of the oil. Any of the working fluid escaping from the cylinders finds its way into the outer casing, either directly or by flowing past the valve and up the passage D, whence it is withdrawn and passed once more through the supply pump.

The construction of the palms of the connecting-rods is not made very clear in the engraving. It may therefore be said that each palm is pointed at one end to fit into a vee-shaped recess formed in the adjacent end of the succeeding palm, and is itself recessed at the other end to receive the point of the preceding palm. Two retaining rings are applied round the outside of the palms to keep them in contact with the fixed crank pin. During the rotation of the cylinder element the gaps between the successive connecting-rod palms close and open, but the movement is very slight.

In the pump—Fig. 92—the rotating element is driven by means of the shaft E, which passes through the centre of the fixed distributing valve F, whereby the cylinders as they rotate are placed in succession in communication with the suction and delivery pipes. In order to obtain a variable stroke, the pistons are arranged to drive against a crank pin composed of two excentrics, one in the form of a shaft lying within the other in the form of a sleeve. The shaft and sleeve can be rotated simultaneously in opposite directions from a single control lever, with the result that the two excentricities may be added together, in which condition the stroke of the pistons is a maximum or subtracted, in which condition the virtual crank pin centre is coincident with that of the driving shaft, and the stroke therefore zero. Further movement of the control handle results in the delivery pipe becoming the suction and the suction pipe the delivery. As the delivery and suction pipes of the pump are connected respectively to the supply and exhaust pipes of the motor, this reversal

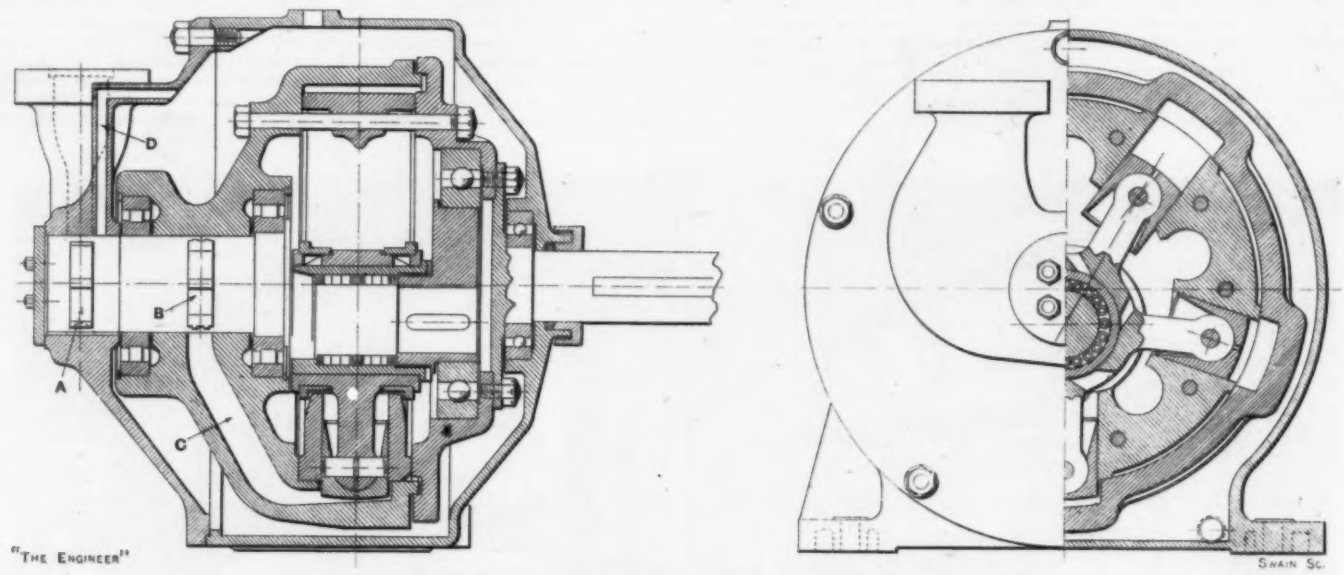


FIG. 91—HELE-SHAW-BEACHAM VARIABLE HYDRAULIC TRANSMISSION GEAR—MOTOR

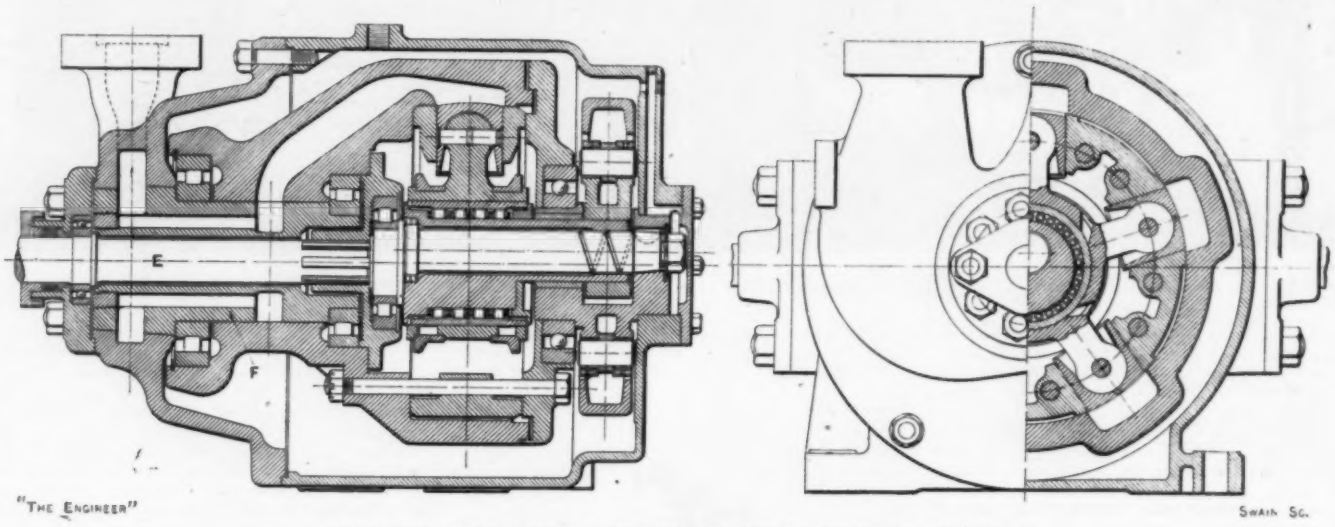


FIG. 92—HELE-SHAW-BEACHAM VARIABLE HYDRAULIC TRANSMISSION GEAR—PUMP

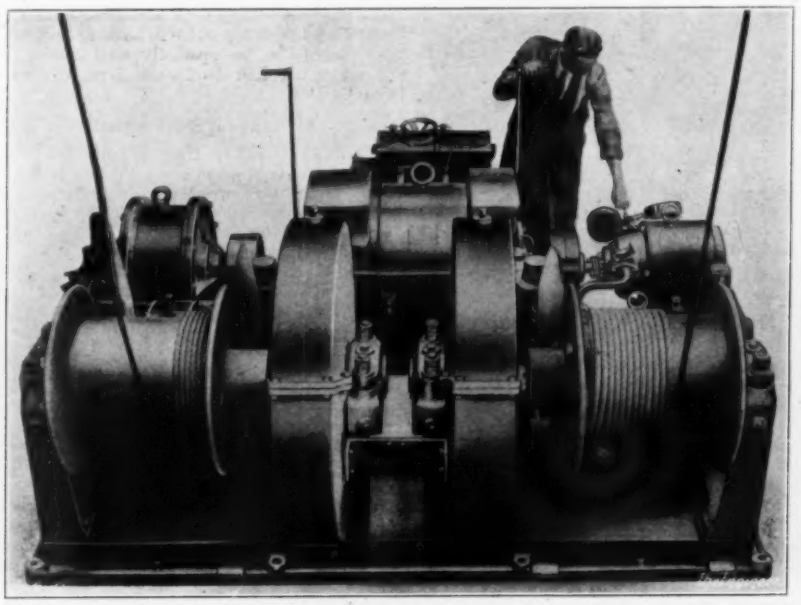


FIG. 93—WINCH FITTED WITH HELE-SHAW-BEACHAM GEAR

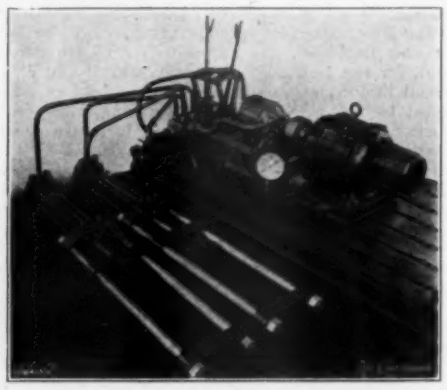


FIG. 94—HELE-SHAW-BEACHAM PUMP AND RAMS

of the connections results in the direction of rotation of the motor being reversed.

At the Exhibition the system was shown applied to a winch driven by a 25 horse-power electric motor. Such an arrangement is represented in Fig. 93, which shows a Hele-Shaw-Beacham hydraulic transmission fitted to a double-barrel winch for the Orient Line. The system was also shown as applied for the transmission of reciprocating instead of rotary motion. In such a case the pump alone is supplied, the motor being replaced by hydraulic rams of the ordinary form. The example of this nature exhibited—see Fig 94—consisted of gear for the operation of the hopper tops of lime kilns. Both the reciprocating and rotary forms can readily be fitted with a pressure-operated governor, which automatically varies the throw of the pump to suit the demand.

The North-Eastern Marine Engineering Company, Ltd.

The North-Eastern Marine Engineering Company, Ltd., of Wallsend-on-Tyne and Sunderland, exhibited a series of models which represented the firm's specialities in connection with steam reciprocating marine engines and boilers, boiler auxiliaries for land and marine work, and North-Eastern marine oil engines. One of the principal models represented a 4000 horse-power quadruple-expansion engine with separately driven circulating water pumps and a Michell thrust block. It is constructed to one-twelfth scale and was shown in operation. Models were also displayed of a pair of marine boilers showing the method of fitting the North-Eastern smoke tube superheater. In this connection it may be mentioned that a full-sized section of a superheater for a locomotive was also displayed, and was shown in section to illustrate the manner in which the tubes are fastened to the header.

The Diesel engine work carried out by the firm was illustrated by a model of the 3000 indicated horse-power eight-cylinder North-Eastern marine oil engine which was supplied to the motor ship Raby Castle, which was described and illustrated in our issue of April 24th. Another model showed the double-acting four-cycle North-Eastern-Werkspoor oil engine, of which there are several units now approaching completion in the firm's erecting shops. In our issue of November 27th we referred to some of the exhibits of marine oil engine parts made in Perlit iron.

J. Halden and Co., Ltd.

Among the various photo-printing machines shown on the stand of J. Halden and Co., 15, Broadway, Westminster, the most novel was that illustrated by Fig. 95, which is an apparatus for photographic reproduction, manufactured in Paris. As will be gathered from the illustration, the apparatus is really a large camera with a prism mounted in front of the lens, so that the object to be photographed can conveniently be laid on a flat table in front. The object is illuminated by a pair of mercury vapour electric lamps, and to this extent the apparatus is not greatly different from other reproducing machines which we have noticed. All the various movements, such as focussing, proportioning, and so forth, are provided with graduated scales, so that no calculation is necessary in setting the machine to do one job or another, and this graduation is carried to the extent of providing a relation between the setting of the gear for cutting off the strip of sensitised paper from the roll, and a mask, or blind, which can be used to screen off part of the paper in the event of the print being

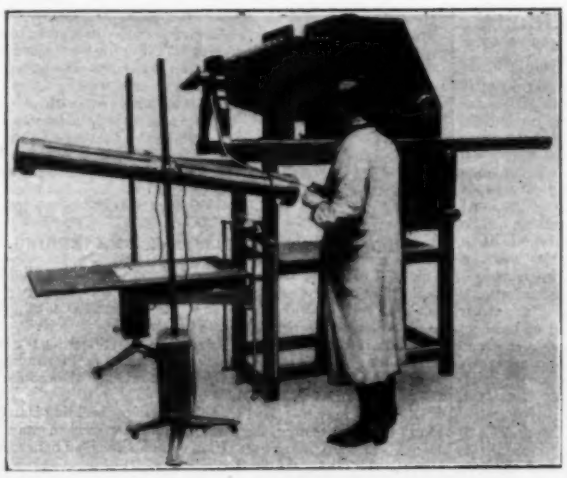


FIG. 95—PHOTO-COPYING MACHINE—HALDEN

smaller than the total area of the exposure. The dial of the cutting-off gear can be seen, plainly, at the side of the machine in the illustration.

Another feature about the machine which struck us was its substantial construction. It is principally of hard wood, with brass fittings, and all the movements worked easily, yet without rattle. There are, of course, fine adjustments for focussing and so forth.

After the sensitised paper has been exposed it is cut off and dropped down into a light-tight bag below the camera through two sliding shutters, so that the bag, and its contents, can be taken away to the dark room for development. The bag, by the way, will hold several hundred prints if necessary. By these means it is possible to work the machine practically continuously, without any delay in exposure during the time while the prints are being developed, and an output up to about three prints a minute can be attained by expert attendants.

When it is desired to make an enlargement a special box is slipped in between the bellows and the back of the camera, and is used to carry the object. Round the inside of the box there are arranged some mercury vapour lamps, which provide a well diffused illumination, which is assisted by a white reflector. For enlargements up to, say, two and a-half times, the sensitised paper is pinned out on the table in front of the machine, but for larger ratios the paper is arranged on the wall of the dark room and the prism of the camera lens is turned round to project in that direction.

The whole apparatus appears to us to be very adaptable to various requirements and is made in the way an engineer like to see things done.

Small Craft and Oil Engines in the New Hall.

In the new hall there was a representative display of small craft and crude oil, petrol and paraffin engines, which was arranged by the members of the Society of Motor Manufacturers and Traders and the Ship and Boat Builders' Association, Ltd. Among the most prominent of the stands in this hall was that of John I. Thornycroft and Co., Ltd., of Thornycroft House, London, S.W. 1. In the illustration reproduced in Fig. 96 we show a view of the 55ft. sea-going motor cruiser Zaza, taken on the Thames. She was a notable boat at Olympia and was designed for service in Havana. She has a length of 55ft. with a beam of 11ft. and a draught of 3ft. 6in., and is propelled by twin-screw Thornycroft petrol motors of 80 to 100 brake horse-power each, designed to give the vessel a speed of about 14½ knots. Another example of a day cruiser was the 48ft. Solent 12-knot cruiser also propelled by a Thornycroft motor, whilst a 28ft. standard cruiser with twin 9 brake horse-power engines was also displayed. Other exhibits on the stand included petrol and paraffin marine engines, from the smallest single-cylinder 7 brake horse-power engine up to the largest twelve-cylinder 375 brake horse-power petrol engine for coastal motor boat work. Electric generating sets for emergency lighting were also shown, as well as Thornycroft propellers and stern gears, oil fuel sprayers and models of torpedo destroyers, coastal boats and high-speed craft of various kinds. The Parsons Motor Company, Ltd., of Southampton, showed a group of Parsons engines applied for such varied duties as ships' propulsion, ships' lighting, lifeboat work, and industrial services such as lighting and welding. Several component parts were displayed showing the details of the firm's re-designed type of engine, which was described in THE ENGINEER of July 17th. Perman and Co., Ltd., of 82–83, Fenchurch-street, London, exhibited two Kromhout marine oil engines, one of which was designed to develop 80 brake horse-power at 350 revolutions per minute, and the other 15 brake horse-power at 500 revolutions. The Bolinder type of engine was shown by James Pollock Sons and Co., Ltd., of 3, Lloyd's-avenue, London, two models of a two-cylinder 60 brake horse-power reversible oil engine and a single-cylinder Beta engine of 6 horse-power, similar Beta engines arranged for stationary work and pump driving were also displayed on the stand. A single-cylinder oil engine, by Mirrlees, Bickerton and Day, Ltd., of Hazel Grove, sectioned and shown in operation, was exhibited on the stand of the Anglo-American Oil Company, Ltd. The special features of this engine were referred to in our article of April 25th last year. A very full range of Ailsa Craig marine motors was shown by the Ailsa Craig Motor Company, Ltd., of Strand-on-the-Green, Chiswick. This popular engine is now built in sizes varying from a two-cylinder 4–6 brake horse-power model to a six-cylinder 28–36 brake horse-power engine. Various units with combined reduction and reverse gears, as well as lighting sets, and two launches fitted with Ailsa Craig engines, were shown. Other exhibitors of petrol paraffin engines included the Atlantic Engine Company, Ltd., of Wishaw; Gleniffer Motors, Ltd., of Anniesland, Glasgow; Morgan and Co., Ltd., of Dover-street, London; Walter D. Fair and Co., Ltd., of Hampton Wick, Kingston-on-Thames; and the Orion Engineering Co., Ltd., of Standard Buildings, Leeds. The Aster Engineering Company, Ltd., of Wembley, showed a full range of both stationary and marine engines, steam pumps and boiler feed water regulators. Some launches were exhibited by J. W. Brooke, Ltd., of Lowestoft, which firm had an extensive display of Brooke motors designed for racing work, along with examples of the Brooke Empire motor and Brooklite self-contained lighting sets. Space will not allow us to mention other firms who exhibited in the New Hall, but will suffice to say that this section of the Exhibition was thoroughly representative and served to show the leading place which is held by British manufacturers in the marine motor industry.

FIG. 96—55-FOOT SEA-GOING CRUISER ZAZA—THORNYCROFT

Institution of Mechanical Engineers.

Two papers dealing with foundry practice were presented before the Institution of Mechanical Engineers at its meeting in London last Friday. The first, by Mr. J. G. Pearce, the director of the British Cast Iron Research Association, was entitled "Cast Iron and Modern Engineering Practice." The second, "Some Applications of Research to Modern Foundry Practice," by Mr. J. E. Fletcher, of Dudley, provided additional insight into the work of the Cast Iron Research Association. We shall reprint it in a future issue.

Mr. Pearce's paper was more or less an introduction to Mr. Fletcher's, and was so described by its author. The following extract from it will, we think, sufficiently indicate its main bearing:—

> The metallurgical characteristics of cast iron are beginning to be understood in such a way as to bring the complete scientific control of its production within the range of practical politics, and this is paving the way for considerable developments in the industry. These appear to lie along the following lines:—The introduction of special irons for particular purposes having such qualities as will win for them either new fields of application or by virtue of their cheapness, fields now dominated by other materials; the development of specialised foundries concentrating on particular qualities of iron; improvements in moulding materials and melting practice leading to greater certainty and economy in production; the continuous application of research for the purpose of revealing more regarding the inner structure and properties of cast iron and the manner in which the information so revealed may be applied in practice.
>
> The ironfounding industry is taking steps to make engineers much more satisfied with both the specific properties and general homogeneity and uniformity of cast iron by the establishment of national specifications and standards. As designers, as users, as foundry owners, engineers, have it enormously in their power to facilitate these steps, and their ready acceptance of the experimental method in engineering development should enable them to do this without difficulty.
>
> Great Britain is favoured in possessing the greatest resources in skilled men and managers. The country lacks opportunities for the installation of labour-saving equipment on a large scale as is common in the United States, and is far behind Germany in painstaking technical investigation. There is danger that this country in a basic industrial process may have to pay tribute to America and Germany for developments in the processes they have made their own, unless the industry can ensure permanent provision for similar work in this country. There is every reason to believe that, with such provision, in ironfounding

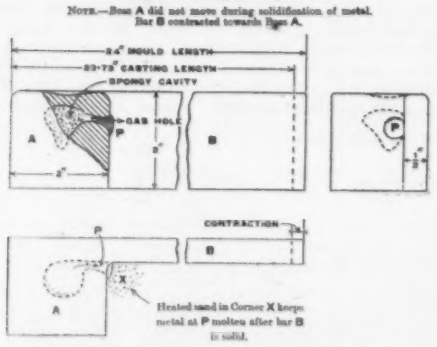
Great Britain could take the lead by virtue of a close combination of theory and practice.

Sir John Dewrance, opening the discussion, said that one most important point brought out by the papers was the necessity for impressing upon blast-furnacemen the great desirability of increasing the uniformity of their product. Years ago he inquired into the secret of a foundry renowned for the excellence of its castings. He was taken by the manager to the yard and shown not one or two, but a great many heaps of different pig irons from which the mixture was very carefully selected. Reliance was not placed on one or two batches, for it was recognised that the proper mixing of the metals was a most important factor in successful foundry work. He hoped also that the Association would take up the question of controlling the amount of sulphur in coke, an element that very frequently proved highly troublesome in cast iron. The "impossible" casting illustrated in Fig. 1 of Mr. Fletcher's paper—reproduced herewith—should teach the drawing-office a

FIG. 1.—*Open Sand Cast.*

Analysis of Iron:—Total Carbon 3·62, Silicon 2·95, Phosphorus 1·20, Manganese 0·67, Sulphur 0·08 per cent.

NOTE.—Boss A did not move during solidification of metal. Bar B contracted towards Boss A.



Contraction of Bar Casting showing location of shrinkage defects and extrusion of Eutectic (C Fe P) at P through gas hole communicating with cavity in heavy boss at internal corner.

"THE ENGINEER" SHAW 9C.

great deal regarding the importance of securing as uniform a thickness as possible in castings and, when a change of section was essential, of making such change as gradual as possible. Concluding, he expressed a desire to see the Association investigating the effect of heat and pressure on iron castings. It was a matter of great importance to determine satisfactorily the limit of temperature up to which cast iron could safely be used.

Mr. John Cameron, president of the Institute of British Foundrymen, said that cast iron was one of the trickiest metals known to science. The chemist and the engineer had succeeded in eliminating the principal points of uncertainty regarding steel and the common non-ferrous metals, but cast iron was as elusive to-day as it was twenty years ago. Nevertheless, progress was being made. A progressive foundryman could give the engineer the metal he wanted if he were told whether tensile strength, transverse strength, or heat resisting capacity were desired. Sir John Dewrance had referred to the casting shown in Fig. 1 of Mr. Fletcher's paper as an "impossible" one, but he could assure the meeting that ironfounders were constantly encountering castings, such as thin cylinders with heavy flanges, of which this illustration might be taken as being typical. Trouble was nearly always encountered at the junction of the thick and thin sections. Mr. Fletcher's explanation of the cause of the trouble threw much new light on the subject.

Mr. P. L. Young dealt with the effect of the shape and dimensions of test bars on the results obtained in an investigation of the strength of cast iron. Tests which he had made with British, continental and American standard forms of test bar had, he said, failed to reveal any significant degree of discrepancy.

Mr. W. W. D. Dale held that foundries were still too greatly controlled by rule of thumb methods. There was too little co-operation between the drawing-office, laboratory and foundry, and he trusted that the papers would lead to an increase in such co-operation.

Mr. G. A. Gardner asked whether the heated-mould or "Perlit" process of making iron castings freed designers from the restrictions hitherto imposed upon them in respect of avoiding the contiguity of thick and thin sections.

Mr. H. B. Weekes said that some foundry foremen professed the doctrine that it was necessary to make a bad casting before a good one could be produced. Such a contention could only be true if there were a lack of co-operation between the designer, pattern maker and foundryman. With such co-operation many troubles would disappear. He believed that 75 per cent. of failures in castings were due to faulty design, and that designers generally were ignorant of the behaviour of cast iron during the cooling period. The British Cast Iron Research Association in this respect was doing very valuable work. The subscription paid by members of that body was based on the number of men employed in their foundries, and varied from about four to about twenty guineas per annum. For that expenditure the members received the benefit of research work representing an expenditure of some £6000 a year.

Mr. F. H. Livens remarked that if the simple fact that iron on cooling contracted ⅛in. per foot were constantly borne in mind, many difficulties would be avoided. It was not enough to make the pattern ⅛in. per foot longer than the finished casting. It had to be remembered that the casting as it cooled was not strong enough to compress the sand. A casting of the form illustrated by Mr. Fletcher in Fig. 1, but having a thick portion at both ends, would fracture during the cooling stage because of its inability to compress the sand between the two ends. He had recently been consulted by his own foundrymen regarding a bedplate casting which was giving great difficulty. It was suggested that the casting process would be simplified if the design were changed. At his suggestion a compressible portion was introduced into the mould, and, as a result, further trouble by fracturing was avoided. Mr. Livens added his testimony to the desirability of charging the cupola with a mixture of pigs drawn from a wide variety of sources.

Mr. W. Reavell expressed a wish to defend the ordinary engineering foundry against some of the remarks that had been made about it. He did not believe that the castings produced in a modern up-to-date foundry attached to an engineering works were in general as bad as had been suggested. In his own works every man followed up his job to its finish. There was no cast iron division between the drawing-office, pattern shop and foundry. It was a standing rule that any casting of slightly unusual form should be discussed by the three departments, and that the castings scrapped each week—about 1 or 2 per cent. of the total output—should be studied in order that the mistake leading to their being scrapped should not be perpetuated. The use of heated moulds was not new. Many had employed them for years, and had apparently unwittingly been producing pearlitic iron. He agreed with the importance assigned to the mixture of irons. If the mixing were carried out under the control of a works' chemist, as good results would be obtained with relatively cheap pig iron as the old fashioned foundry foreman could secure with his partiality for cold blast and other special pigs.

Mr. J. G. Pearce, replying to Sir John Dewrance, stated that the British Cast Iron Research Association would proceed with some of the lines of investigation mentioned by Sir John as soon as its financial resources permitted it to do so. Mr. Reavell was an excellent champion of engineers and designers. His foundry at Ipswich was one of the most modern and best run on the East Coast.

Mr. J. E. Fletcher remarked that many of the problems presented to the Association for solution were produced by a misconception of fundamentals. Changes in the structure of metals during the cooling stage required much more emphasis than abrupt changes of section, a defect in design now avoided by nearly all draughtsmen. The fracture of the casting referred to by Mr. Livens was not wholly produced by the resistance of the sand but was, in part, caused by the weakening of the metal at the corner arising from the retention of heat in the sand. As regarded the "Perlit" process, he was not fully in a position to state that it gave homogeneity in every case, but the process was fundamentally sound, and great developments were probable. The defects commonly found in ordinary castings frequently did not persist in castings made in hot moulds.

MANCHESTER ASSOCIATION OF ENGINEERS.

"MODERN Physics and its Bearing on Engineering Progress" formed the subject of a very interesting paper which was read by Mr. A. P. M. Fleming, M.Sc., M.I.E.E., before the Manchester Association of Engineers on Friday last, December 11th. The author said that apart from civil engineering, all engineering to-day was based on comparatively few fundamental discoveries. Inventions and economic conditions had compelled the efforts of engineers in general to be applied largely to refinement and enlargement of those fundamental inventions. In recent years physical knowledge had developed at a vastly accelerated pace. Just as in the past the work of the physicist had provided the seed for engineering development, it was not less likely that the germ of future inventions would be derived from the same source. The author then proceeded to direct attention to the trend of modern scientific thought and to consider some of the directions from which discoveries bearing on engineering progress may be expected to emanate. He said that recent physical knowledge was finding its application in three most important fields of engineering practice. It had provided a means of examining the ultimate structure of the aterialsm of engineering construction with far-reaching possibilities for their improvement. Through the light it had shed on high-voltage phenomenon, it had been the means of facilitating the rapid development of high-tension electrical transmission which had become so fundamentally a necessity in our modern industrial and economic life; in the field of thermionics it had provided the possibility of new energy translating devices, the ultimate scope of which was as yet undetermined. The possibility of tapping directly the energy of the sun or of deriving energy from the disruption of the atom was speculative only; but activity in either of these fields will undoubtedly be the result of new scientific knowledge. Hence the desirability for engineers to keep themselves well informed of the work of the physicists.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH RAILWAY STATIONS AND STATION APPROACHES.

SIR,—Permit me as an old locomotive enthusiast to express my great appreciation of your splendid series of articles on "British Steam Locomotives," which represents an admirable record of progress. May we couple with such appreciation the wish or hope that before long you will be in a position to publish a similar series, but dealing with traffic and railway station technique? I venture to think that such a record would hardly be as satisfactory reading as the one on locomotives from the point of view of showing progress in anything like the shape as that justly claimed for the locomotives. I am often set puzzling how to square the locomotive engineer's splendid efforts in producing these magnificent and powerful engines, with the too obvious indifference displayed by the railway companies (of England in particular) with regard to the construction of approaches to important stations and termini, the lay-out of these stations and lack of the most elementary accommodation. These drawbacks react upon the conduct of the traffic in such a serious way that the real efficiency benefit of the locomotives, however powerful and fast, is to a great extent simply lost. Even the most casual observer is bound to think it is all very fine to have these fine engines, but what is the good of it when station approaches and station accommodation are so miserably inadequate that delays are serious in magnitude and chronic in frequency, if they are not actually permanent. The extent to which parties attached to the railway companies of this country responsible for the lay-out of station approaches and stations militate against quick and efficient handling of the traffic is one of the wonders of our time. The extent to which this ineptitude reacts upon the everyday business of employers as well as of employed, by robbing both of countless hours of work, is simply appalling when figured out in the aggregate. A country like England, particularly situated as at present, badly requires and should peremptorily insist upon reliable and quick services, both for passengers and goods, and the railway companies should be deprived legally of some of their too ready inclination to treat time-tables as so many scraps of paper, evading all responsibility by the mere concoction by themselves of so-called rules or traffic paragraphs.

The waiting rooms of most British railway systems are an absolute disgrace. Booking offices and passages for ingress and egress seem to be devised to cause the maximum of confusion in busy hours instead of being designed for and operated with a view to the quick dispersal of arriving train loads or the quick occupation of outgoing trains. Some of these perfectly idiotic things have to be witnessed and experienced to be believed possible, and I have so far only mentioned these very few items. Therefore, Sir, should you favour your readers with a corresponding series of articles on modern railway station technique (and architecture), please permit your contributor to disregard the feelings of those responsible for the present-day discreditable conditions prevailing at too many stations and their approaches, a condition of things wholly out of keeping with the expectations encouraged by the progressive history of the locomotive. I am not referring to the usually excellently constructed permanent way nor to the invariable courtesy shown by officials and employees.

ALBERT ALFRED BUSS.

Chorlton-cum-Hardy, Manchester, December 12th.

COMPOUND LOCOMOTIVES.

SIR,—Whatever may be the results of the road tests with the Delaware and Hudson 2–8–0 cross compound and of the Boston and Albany 2–8–4 simple engine, it is certain that we in this country have reached a high standard of locomotive efficiency.

A test made in 1902 with No. 2631, the first of the then Johnson three-cylinder 4–4–0 Smith compounds, and presumably working at 195 lb. per square inch—the pressure adopted by Mr. Johnson for this type—showed that the coal consumption was as low as 2·16 lb. per indicated horse-power hour, when working an express train from Carlisle to Leeds. The water used per indicated horse-power hour was 22·5 lb., and the water evaporated per pound of coal 10·45 lb. The engine was not fitted with a superheater.

The dynamometer tests carried out with Mr. Collett's four-cylinder superheated simple 4–6–0, No. 4074, Caldicot Castle, gave results which were equally noteworthy, the coal burnt per indicated horse-power hour being 2·1 lb., the water used per indicated horse-power 20·9 lb., and the water evaporated per pound of coal 12·2 lb.

These excellent performances were obtained with straightforward and comparatively inexpensive designs of locomotives.

I agree with your correspondent "R. C." that reasonably late cut-offs have certain advantages, not the least of which is a better M.E.P.

F. W. BREWER.

Stevenage, Herts., December 12th.

CHEMICAL AND COMBUSTION ENGINEERING.

SIR,—I sincerely hope that the scheme for making Finsbury Technical College a centre for teaching chemical engineering will succeed, and I also suggest that the systematic teaching of combustion engineering be located there.

Chemical engineering and combustion engineering are very much akin, because combustion engineers and fuel technologists must necessarily have considerable knowledge of organic and inorganic chemistry.

Objection may be raised that the Finsbury building is unsuitable for boiler testing, &c., but no doubt arrangements could be made at a nearby power station to run occasional boiler trials.

If the above be carried out, Finsbury College might also become the headquarters of the Institution of Chemical Engineers and also of a new Society of Fuel Technologists or Combustion Engineers, which latter is badly wanted, because of the great advances now being made.

It is becoming the fashion to locate scientific and engineering societies in colleges; *e.g.*, the present address of the American Electrochemical Society is at the Columbia University, New York City, and at one time it was at Lehigh University.

Another suggestion I make is that a scholarship for combustion engineering be founded to perpetuate the name of Bettington, a principal pioneer of pulverised fuel firing, who lost his life as an aviator in the war.

E. KILBURN SCOTT.

London, December 10th.

Railway Matters.

THE London and North-Eastern Railway had the misfortune, on the 8th inst., to have its biggest dock warehouse in Hull destroyed by fire. The warehouse was 600ft. long and had a capacity of 100,000 tons.

MENTION was made in this column of our issue of February 15th, 1924, that Sir Herbert Walker, the general manager of the Southern Railway, had informed the local authorities that Wimbledon Station would shortly be reconstructed. It is now announced that the work has been begun, and will take 2½ years to complete, at a cost of £250,000.

AS a Great Western tank engine was running near West Acton Station, on the Ealing and Shepherd's Bush section of the Central London Railway on Thursday, the 10th inst., one of the connecting-rods broke and pierced the boiler. The fireman was blown off the footplate and received fatal injuries. At the coroner's inquest a verdict of "Accidental death" was returned.

AT the beginning of the meeting of the Institution of Mechanical Engineers last Friday, Sir Vincent Raven intimated that that occasion would be the last on which he would occupy the chair during his year of office as President. The Government of India, he said, had invited him to act as chairman of a committee appointed to inquire into the working of the Indian railways, and in order to fulfil that duty it would be necessary for him to leave this country in the course of a week's time.

THE National Union of Railwaymen has issued a circular to its members explaining the award of the National Wages Board. It is signed by the President and by Mr. J. H. Thomas, and concludes, "With a full sense of our responsibilities, we recommend our members to accept the findings," and winds up: "We urge every member to co-operate whole-heartedly with the management so to promote the efficiency of the railway service as to attract to the railways the maximum amount of potential traffic in the country, and so assist to restore in the most natural way the prosperity of the industry on which members depend to provide them with the means of livelihood."

THE report by Lieut.-Colonel Mount on the fatal collision of September 3rd at Hope, on the Midland section of the London, Midland and Scottish Railway, was issued on Friday last. It will be remembered that a down ballast train was shunted on to the up line to allow another down train to pass, and that whilst on the up line it was run into by an up express for which the signals were improperly lowered. It has been generally assumed that the ballast train was overlooked by the signalman, but it would seem as though it was the express which was forgotten. It is the conclusion of Colonel Mount that "grave responsibility for this regrettable accident rests solely with the signalman. He frankly admitted his failure, which was of a serious type."

SPEAKING at the Newport (Mon.) Chamber of Commerce on Friday evening last, and therefore after the award of the National Wages Board, Sir Felix Pole, the general manager of the Great Western and a signatory of the majority report, said: "The one thing that I hope has been secured is peace in the railway industry. If a period of industrial peace is assured, then all parties—the country at large, railway shareholders, and railway employees—may congratulate themselves. Above everything else, we want peace in our industry as well as in other industries—a long peace in which we can devote our energies to the scientific elimination of waste, the introduction of new and improved methods of operation, and the development of a spirit of co-operation between railway companies and their customers on the one hand and their employees on the other."

THE award of the National Wages Board as to railwaymen's wages was published on Wednesday, the 9th inst. Neither the men's demand for an increased nor the companies' application for a reduction was entertained, but the latter obtained a decision to the effect that the present rates do not constitute an irreducible minimum. Further, it is provided that all entrants into railway service after February 1st next shall be paid at the basic rate, but without the cost of living bonus. The award concludes by drawing attention to the disadvantages the railway companies labour under with respect to road competition, and says, "The unfairness of this position is further emphasised by the fact that the railway companies are not permitted a free use of the roads. They are thus put in a position of assisting to subsidise a formidable and increasing competition, a state of affairs which ought not to be allowed to continue." Three of the railway representatives present a minority report, in which they "regard the present burden of labour costs as being economically unjustifiable"; but it is significant that Sir Herbert Walker and Sir Felix Pole sign the majority report. The men's representatives, in also signing the latter, thus approve of the lower rates for new appointments.

THE assumption made in this column last week that the Fenny Stratford level crossing disaster of the 7th inst. would be inquired into by the Ministry of Transport has proved to be correct. The investigation was in charge of Major Hall, but in the middle of the proceedings on Friday last a request was received from the coroner that the inquiry should not be held in public. Major Hall thereupon requested the public and the representatives of the Press to retire, but impressed upon them that such a step was not taken at the wish of the Ministry. The object desired by the coroner was, of course, to prevent his own inquiry being prejudiced, and his action is useful as answering the objections that have sometimes been raised in the daily Press when the inspecting officers of the Ministry of Transport have held their inquiries within closed doors. The reason for that action has been that men who are liable to be incriminated by their statements can speak franky and freely when they know that what they say will not be made public. The inspecting officer's inquiry gains by that step too, as the witnesses keep nothing back and all the facts are known. Moreover, the purpose of his investigation is not so much to find out who was to blame as to see what should be done to avoid a repetition.

Notes and Memoranda.

IT is proposed to build a hundred dams across the river Tennessee and its tributaries to develop 4,000,000 horsepower.

A SYSTEM of automatic train control, invented by Mr. Thomas E. Clark, is said to have given excellent results in trials at Detroit. A transmitter by the roadside projects electro-magnetic waves, and these produce impulses in the rails which operate light signals on the engines and apply the brakes of trains in emergencies.

WE have just received notice of two fine examples of the steel maker's art. One was a wire rope 7¼ miles long, in one piece, and weighing 56 tons, made by Thos. and Wm. Smith, of Newcastle. The other was a hardened and tempered steel conveyor band 377ft. long by 24in. wide and 0.04in. thick, made by the Sandvik Company, of Sweden.

THE method of repairing boilers by depositing a layer of metal by a welding process on a corroded part is becoming common, but repairs of this kind, unless very carefully performed by skilled operators, are liable to give out. A more reliable method, according to a recent Board of Trade report, is to cut out the defective part and fit a substantial riveted patch.

A SHORT article in the *Chemical Trade Journal* on the synthesis of ammonia, contains the information that the possibility of working at the low temperatures and pressures—100 atmospheres and 400 deg. Cent.—of the Mont Cenis system, depends upon the discovery of a new and exceedingly potent catalyst, the constitution and method of preparation of which are as yet to be kept profound secrets.

AMERICAN cities appear to be suffering from the same trouble as London through the inadequate foundation of roads, and the *Engineering News-Record* remarks that Chicago, for instance, has experienced in the last two or three years an enormous increase in street traffic. Thoroughfares adequate only a few years ago are entirely inadequate now, partly because of weak pavement structure but chiefly because of poor surface and lack of width.

A RECENT issue of the *Engineering News-Record* contains a description of a suspension bridge, still in service, which was built in California in 1862. The span is 258ft. and is carried by two cables 11¾in. in diameter. These cables were first used for a bridge higher up the river, which was built about 1849. In 1862 that bridge was dismantled and the cables were dragged down the river and used in the present bridge, which is still good for loads up to 8 tons.

ACCORDING to the *Electrical Review* experiments have been in progress since the end of September at the wireless station at Colombo, where a new continuous-wave plant is in use, to ascertain whether it is possible to establish regular direct wireless communication on a commercial basis between Colombo and Perth, in Western Australia. Communication has been readily established, and the object of the experiments is to discover whether it can be maintained at all hours of the day and night and under all conditions. The new plant will be used also for broadcasting purposes on an 800 m. wave length.

DURING recent years the method of early burning of forest areas, in which the fire would cause little damage, has been introduced in some countries having large tracts of forest so as to reduce the area actually protected. Its advocates maintain that unless protection from fire can be completely assured and the expense of such protection be justified, it is better to fire the areas departmentally early in the season as soon as the grass, &c., is dry enough to burn, than to risk the forest being burnt in the hot weather when the fire is much more severe and the probability of damage greater.

COMMENTING on an explosion in a boiler twenty-five years old on board a small coasting steamer, the Engineer-Surveyor-in-Chief to the Board of Trade remarks that the practice of stopping leakages at cracks in furnaces by screwing plugs or studs from the fire side of the plates is commonly resorted to when leakage occurs at sea, but owing to the comparatively thin plates into which the plugs are screwed the repair should be regarded only as a temporary expedient, and a permanently riveted or welded patch should be fitted at the earliest opportunity. Numerous cases have occurred in which a boiler has been disabled as a result of these plugs or studs being blown out.

SPEAKING on the subject of the commercial application of fuel oil, before the Institution of Engineers and Shipbuilders in Scotland, Mr. A. F. Baillie said that the oil firing of large regenerative glass-making tanks previously fired by producer gas should be carried out in the following manner. Suppose that the tank is fired by four gas ducts on either side alternately for half an hour's duration. In order to convert this tank for oil burning, the gas ports should be blocked up, the air ports re-designed, and the furnace crown lowered. Oil burners should be fitted into the top of the four gas ports as they enter the furnace, two burners being fitted to each gas port. The burners should be of the compressed air type working at a pressure of about 15 lb., and given a downward tilt in order that the flame might play on top of the molten glass.

IT is well known, says *Nature*, that earthquakes are either not felt at all or felt only slightly in railway tunnels and mines, even when the shocks at the surface are very strong. In the great Japanese earthquake of September 1st, 1923, the damage to tunnels was very slight, and occurred only a few yards from either end. To determine the rate at which the amplitude decreases with increase of depth, Mr. S. Nakamura placed two of Omori's tromometers, one in a transverse shaft connecting two parallel tunnels each 1¼ miles long at a depth of 375ft. below the surface and nearly 500 yards from the northern end, the other just outside the tunnel at that end. Comparisons were made for nine earthquakes during the first three months of the present year, and they show that, as a rule, the amplitude of the principal vibrations was less in the tunnel than outside, the ratio ranging from 0.19 to 1.93. Though the general variation in the ratios of the amplitudes with varying periods agrees approximately with that computed from the formula for the Rayleigh waves, the agreement is not close enough to allow the inference that the observed waves were the Rayleigh waves.

Miscellanea.

THREE wells supplying helium gas in workable quantities have been sunk at Inglewood, near Toronto.

THE machinery for the new beet-sugar factory at Peterborough is to be supplied by an American firm.

DURING the month of October the record amount of 220,000 tons of merchandise was handled at the docks of Capetown.

THE machinery for the two new cruisers to be built in the Royal Dockyards will be supplied by Vickers and the Fairfield Company.

A NEW record was established by the steel works at Sydney, Nova Scotia, in October, when 37,224 tons of ingots was produced.

AN experiment is being made in Korea on the cultivation of sugar beet, and 7352 acres are being planted. The soil requires deep tillage.

THE output of refined and crude white arsenic in the United States in 1924, according to producers reporting, exceeded previous records and amounted to 20,177 short tons.

ARRANGEMENTS have been made by the Smoke Abatement League of Great Britain to hold a "Universal Smoke Abatement Exhibition," in Bingley Hall, Birmingham, in September, 1926.

AN International Oil Exhibition is to be held at the Crystal Palace next year, from April 21st to May 8th. During the Exhibition it is intended to hold an International Petroleum Congress.

AN indication of the progress being made by the gold mining industry in Ontario is given by the fact that one mine, the Hollinger, is now crushing 5300 tons of ore every twenty-four hours, as compared with 1777 tons per day in 1920.

THE President of the Bolivian Republic has promulgated a decree permitting the erection of broadcasting stations and setting forth a code of regulations. The broadcasting system will be under the control of the Director-General of Telegraphs, and a nominal tax will be levied on all receivers to cover the cost of administration.

THE British Consul at Stockholm reports that a proposal has been put forward for the formation of a company to supply electrical power to the Island of Oland. Under the scheme for such supply it is proposed that power should be taken from the hydro-electric power stations on the mainland (probably Sydsvenska Kraft—A/B, Malmo) and transmitted by a high tension submarine cable to Oland, and further distributed to the different parts of the island by aerial cables at low tension.

THE magnitude of the work which is entailed in the construction of the new Welland Canal may be judged from the fact that a recent survey shows that five years will be required before the work is completed, notwithstanding that it was begun several years ago. There are at present 3000 men employed. Every section of the canal is under way or completed. At the Port Weller end the dredging has been finished, the concrete work for locks 1 and 2 completed, and machinery is being installed for the valves. During the winter the preliminary work will be undertaken for the crossing of the big canal under construction and the one now in use. The crossing will be effected at the head of lock 3 and is one of the most interesting phases of the gigantic undertaking.

AN extensive programme of public works has been undertaken by the Republic of El Salvador. In 1923 a contract was awarded to R. W. Hebard and Co., Inc., of New York, for the sanitation and paving of the capital city, San Salvador, and the Pacific port of La Libertad. The work consists of sewerage, waterworks and concrete and asphalt paving, and is being executed over a five-year construction period. In October of this year the Government of Salvador contracted with the same company for the construction of over 1250 kiloms. of modern highways. The work is planned to extend over a six-year period. In addition to these public works, the International Railways of Central America are building a line from San Salvador to Guatemala, which will connect the Salvador railway system with that of Guatemala.

ACCORDING to General Wu Te-ching, chief military engineer for the North-Eastern Army and manager of the Chinese Telegraph Administration at Shanghai, work was to commence on October 15th on the first long distance telephone service in that part of China, connecting Shanghai and Nanking and also bringing within speaking range of Shanghai the cities of Soochow, Wusih, Changchow, &c. It is hoped to have the line completed by January 1st, 1926. Another long distance line, stretching from Nanking to Tsinanfu, *viâ* Tientsin, was to be started simultaneously. The total cost of the lines from Shanghai to Nanking and from Nanking to Tsinanfu will be approximately 300,000 dollars. The rates charged for using the service will probably be 3.50 dollars for five minutes' conversation between Shanghai and Nanking, 8 dollars for five minutes' conversation between Shanghai and Tientsin, and 4 dollars for five minutes' conversation between Tientsin and Mukden.

IN its annual report, which has just been published, the Smoke Abatement League of Great Britain says that it is striving its utmost to carry out its aims and ideals, but is hampered at every turn by lack of means, although not a penny is spent on salaries, office rent, rates, &c. The conference at Manchester, November 4th to 15th, 1925, resulted in a loss of £289 4s. 2d., and the consequent overdraft at the bank has severely crippled the work. It is confidently hoped that many local authorities will subscribe handsomely through their Public Health, Gas and Electricity Committees to the funds of the League. A number of business houses in Manchester have become yearly subscribers, fully recognising the extra cost they are carrying owing to the dirty condition of the atmosphere. The subscription list of to-day should, it is urged, be multiplied many times to permit the work of the League, which, it points out, is national in character, to be carried out efficiently. What has been done is, it adds, only a small part of what could and would be done if real support were given by all classes of the community.

THE HELL GATE ELECTRIC GENERATING STATION, NEW YORK

(For description see page 674)

FIG. 1—GENERAL VIEW OF THE STATION TAKEN FROM AN AEROPLANE

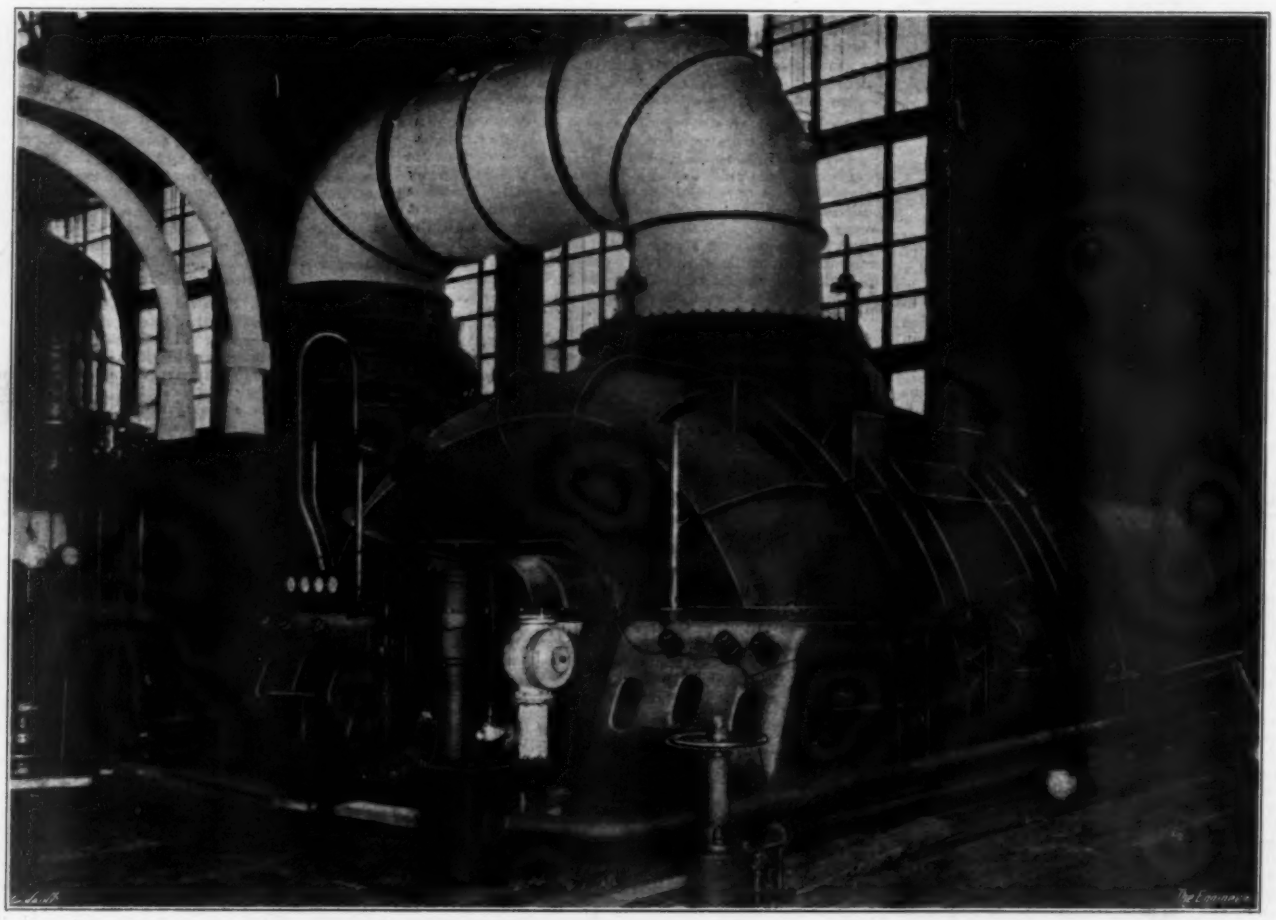


FIG. 2—50,000 K.W. CROSS-COMPOUND PARSONS-WESTINGHOUSE TURBO-GENERATOR

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The Engineer

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DEATH.

ON December 13th, at 95, Tyrwhitt-road, St. Johns, London, S.E., GEORGE A. MILLER, Chairman of W. H. Willcox and Co., Ltd., of 38, Southwark-street, London, S.E. 1, in his 76th year.

THE ENGINEER.

DECEMBER 18, 1925.

The Future of the Battle-Cruiser.

IT is widely assumed that the Washington Treaty, by restricting the displacement of future capital ships to 35,000 tons—exclusive of fuel and reserve feed water—has definitely "killed" the battle-cruiser. As this view has been publicly expressed by naval officers of the highest distinction, some diffidence must be felt in putting forward a contrary opinion. We are emboldened to do so, however, by the reflection that the demise of the battle-cruiser was announced shortly after the Washington Treaty saw the light, when there had scarcely been time for a close scrutiny of the clauses relating to new construction. It is possible that many who then thought the battle-cruiser doomed have, on maturer consideration, modified that view. In any case, the question has a practical interest for students of naval affairs, since the building of capital ships must be resumed in a few years' time, if this country is to maintain its position at sea. Much may happen, of course, between now and 1931, in which year we are entitled under the Treaty to lay down two further capital ships; but there is no reason to suppose that anything will occur in the interval to shake the faith which the Admiralty, and, for that matter, almost the entire Service, retains in the capital ship as the backbone of the Fleet. Probably, therefore, the two new ships will duly be laid down in 1931.

With the dimensions of our battle fleet so rigidly limited by international compact, the design of individual ships has become a matter of exceptional importance. The selection of each new type must be governed in large measure by the concurrent building activities of other Powers. The Nelson and the Rodney, our first capital ships begun after the Washington Conference, are battleships pure and simple, vessels of this type being urgently required to bring our Fleet up to the ratio of strength prescribed. Understood to be of moderate speed—23 knots has been mentioned unofficially—they are nearer the Royal Sovereign than the Queen Elizabeth in regard to mobility. In armament and protection they are likely to surpass every other ship afloat. The "Nelsons" will therefore be a valuable reinforcement to the battle fleet; but had it been possible to endow them with a higher speed, their strategical and tactical value would be considerably greater. The advantages of great speed need not be laboured. To the British Navy, in particular, it is an asset of inestimable importance, and never more so than at the present time, when the main theatre of naval strategy has been transferred from home waters to remoter areas, where we do not now, and shall not for years to come, possess the local facilities for maintaining a battle fleet. It follows, therefore, that the rapidity with which our Fleet is able to reach the danger zone may be a determining factor in any future campaign. Circumstances may easily be imagined in which six 31-knot "Hoods" would be worth more than eight 23-knot "Nelsons." So much for the strategical aspect of the question. The tactical utility of high speed is self-evident. Immediately after the war there was, it is true, a tendency in naval circles to favour ships of moderate speed but greatly improved protection. That was but natural, in view of the unsatisfactory experience our commanders had had with battle-cruisers in which resisting power had been ruthlessly sacrificed for the sake of an extra knot or two. What they really wished was to see the two qualities combined in one ship. The design of the Hood, and still more that of the four "super-Hoods" of 1921, which were cancelled in deference to the Treaty, proves that naval opinion fully appreciates the advantage of great speed when it does not involve the loss of adequate protection. Our earlier battle-cruisers, in spite of their limited powers of resistance, demonstrated their value time and time again. That being so, who can doubt that the same type, in an improved form, would be equally useful in future naval warfare? Our present-day Fleet contains four battle-cruisers, but although only one is of modern design, it is significant that foreign critics invariably credit the British battle fleet with more than its nominal degree of relative strength because it includes this quartet of fast ships. Battle-cruisers represented more than one-third of the American post-war building programme which the Treaty cancelled; the corresponding Japanese programme made provision for an equal number of battleships and battle-cruisers. There could be no clearer proof of the esteem in which the battle-cruiser is held by international naval opinion than these facts afford. If, therefore, its perpetuation is still possible within the limits of the Treaty, the wisdom of including the battle-cruiser type in future building programmes hardly calls for argument. It remains, then, to consider the real issue: whether it is feasible to design a ship of 35,000 tons "standard" displacement, which, in addition to adequate armament and protection, would have a speed considerably above that of the ordinary battleship. In the first place, it is important to remember that "standard" displacement does not include fuel or reserve feed water, whereas "normal" displacement, as understood in this country, includes about half the amount of fuel normally carried. Actually, therefore, a standard displacement of 35,000 tons is equivalent to a normal displacement of about 38,000 tons—that is, 11,500 more than the Renown and only 3200 tons less than the Hood. The ships named are designed for 31 knots, but future battle-cruisers need not of necessity have this very high speed. Ships of 28 or 29 knots would probably answer all requirements, seeing that post-Treaty battleships are never likely to exceed 23 knots. When we consider that the Queen Elizabeth, a well-protected ship mounting eight 15in. guns, with a speed of 25 knots, has a normal displacement of 27,500 tons, it is evident that with an additional 10,500 tons to dispose of, it would not be hard to design a ship with an armament at least as heavy, protection equally good, and a speed of 29 knots. We would go so far as to predict that on a displacement of 38,000 tons it would be possible to mount nine 15in. 45-calibre guns—as against the 42-calibre guns in Queen Elizabeth—to increase the protection to vitals, and to attain with ease a speed of 29 knots. This we believe to be a conservative estimate of what our constructors could accomplish if it were decided to resume the building of battle-cruisers. The notion that 16in. guns, as sanctioned by the Treaty, are a *sine qua non* in all new capital ships, we hold to be fallacious. A new high-velocity gun of the well-tried 15in. calibre would satisfy all reasonable demands as to range, precision and destructive power. It is unnecessary to recall what happened at Jutland, when the German Fleet, mounting nothing larger than 12in. guns, contrived to make excellent practice against opposing ships armed with 13.5in. and even 15in. weapons. If, however, the 16in. calibre is regarded as indispensable, it would still be practicable to mount this gun in a post-Treaty ship of very high speed by reducing the number of pieces to six.

Such a design was worked out by Sir George Thurston in "Brassey's Annual" for 1923. This ship, with a legend—British—displacement of 36,000 tons, was to have 30 knots speed, vertical armour of 13in. to 14in., and a main battery of six 16in. 45-calibre guns. We consider, however, that nine guns of 15in. would be preferable for tactical purposes, since the long ranges at which future actions are likely to be fought will render volume of fire a factor of cardinal importance. We are also of opinion that a 15in. 45-calibre gun, firing the newest type of armour-piercing shell, would be sufficiently powerful to overcome the armour protection of the strongest battleship now afloat or capable of being built under Treaty restrictions.

We repeat our conviction, which we know to be shared by a great many naval officers, that the peculiar necessities of Empire defence render imperative the inclusion of high-speed ships in our future battle fleet. Such vessels would have an advantage that our earlier battle-cruisers did not possess, namely, ability to meet battleships on comparatively equal terms. In effect, they would be swift battleships, a type which has always been cherished in the British Navy, and which is now needed more than ever in view of the strategical problems of the post-war era. It is worthy of remark that the Germans, who shared with us the experience of Jutland, continued after the lessons of that action had been pondered over to design battle-cruisers which differed from battleships in the weight of their armament. Thus the Ersatz Freya and the Prinz Eitel Friedrich, laid down in 1917, were each to have mounted eight 14in. guns, whereas coeval German battleships were provided with the like number of 15in. guns.

Converting Plant.

THE letters on motor converters *versus* rotary converters recently published in our correspondence columns open up an old controversy in which well-known electrical designers originally took part. On account of the difficulties of getting early rotaries to run satisfactorily with fifty-cycle current the motor converter was evolved, and although it met with a hostile reception from certain electrical manufacturers, it made appreciable headway. The renewed discussion on the relative merits of the two machines is really nothing more than a repetition of the controversy which raged nearly twenty years ago. Before the advent of the motor converter there were but two types of converters—the low-efficiency motor generator and the rotary converter. Mr. La Cour's motor converter, composed of two machines mechanically and electrically connected, ran much more satisfactorily than the 50-cycle rotaries, which, nevertheless, had and still have a slightly better efficiency. While the motor generator transforms all the electrical power supplied to it into mechanical power and then back again into electricity, the motor converter transforms part of the power—usually half—electrically, and is therefore more efficient than the motor generator, although slightly less efficient than the rotary converter. One of the advantages claimed for the motor converter is that the direct-current part of the machine usually runs at a speed corresponding to half the supply frequency, with the result that the reduced number of poles for 50-cycle operation gives an increased brush spacing, and there is little risk of flashing occurring between brushes of opposite polarity. But since the time when it became possible to construct converter commutators for high peripheral speeds, many eminently well-behaved 50-cycle rotaries have been built, and it can no longer be said, or at any rate be proved, that this type of converter is only suitable for 25-cycle supplies. Certain electrical firms that have recently taken up the manufacture of motor converters have increased the speed to a comparatively high value, so as to produce machines that occupy a small amount of space for a given output.

Rotary converters have always been favoured in the United States, where much 25-cycle generating plant has been put into service. Similarly, in this country the adoption of 25-cycle current was brought about in no small measure by the fact that the early rotaries would not run well with 50-cycle current, and if the motor converter had been introduced earlier, the problem of standardising frequency would now be a relatively simple one. The motor converter still remains a thoroughly good machine, but several of its original outstanding advantages have undoubtedly almost completely disappeared. In a series of articles on "Modern Converting Plant," published in THE ENGINEER in 1923, we referred to the fact that certain old arguments in favour of motor converters were no longer very weighty. A great point was originally made of the ease with which motor converters could be put into operation, but with the introduction of the self-synchronising rotary this advantage practically vanished. The possibility of supplying the three-phase current at a pressure of 11,000 volts directly to the stator windings has undoubtedly often led engineers to use motor converters, but pressures are steadily rising, and it may happen that in the future transformers will very often be required in any case. We hold no brief for any particular type of converting plant. In fact, we should like to see most of it abolished. If the Electricity Commissioners or some other competent body would get together statistics showing the amount of money invested in converting machinery in this country, and the total annual loss involved, it is not unlikely that some attempt would be made to curtail its use in the future. Rather than discuss the merits and demerits of two admittedly good types of converters, it would be more profitable, we think, to consider what can be done to get rid of some of the plant that is already in existence. In certain parts of London and elsewhere there are supply undertakings which use converters of the most uneconomical kind, namely, motor generators. These machines have, of course, certain inherent advantages, such as complete electrical separation of the alternating and direct-current sides, power factor correcting properties, and wide direct-current voltage regulation; but it is doubtful if their existence can now always be justified. A great deal is said and written in these days about raising the efficiencies of generating stations, yet outside losses and operating expenses apparently do not matter. In a paper read some years ago on the London County Council tramways, Mr. Rider gave the annual efficiency—*i.e.*, the ratio of output units to input units—of the synchronous motor generator sub-stations as 73.5 per cent., and that of the induction motor generator sub-stations as 82.1 per cent. The Government is about to launch a scheme for the standardisation of frequency and to give financial aid for its realisation, but in our opinion there are also other ways in which the State might assist the electricity supply industry. Direct current has become too firmly rooted to be abolished altogether. Rather than perpetuate direct-current distribution, however, it is well to consider whether it is not worth while superimposing an alternating-current system, or to change-over the system altogether. In view of the very heavy domestic and other loads that are expected, the inadvisability of continuing to connect all consumers to the direct-current network is pretty evident. At Birmingham, power consumers with motors rated as low as 30 horse-power are now connected to the 5000-volt three-phase system. The continued practice of feeding into an existing low-tension network through manually or automatically controlled sub-stations for the purpose of improving the voltage and assisting overloaded feeders is a scheme with which we have little sympathy. Not a few central station engineers, we fancy, would like to see the last of their direct-current distribution systems; many, in fact, are far more interested in relieving their direct-current feeders of load than they are in the task of changing frequency.

Manufacturers have got to face the fact that sooner or later converting machinery will, to a large extent, go out of fashion. Apart altogether from changes to alternating-current distribution, the rectifier will, in our opinion, eventually become a very keen competitor of all revolving converters. It is a great advantage, especially in these days of costly labour, to be able to use a static piece of apparatus in place of a machine. We are not unmindful of the fact that converting machinery can be made to look after itself—to start up and shut down, &c., on its own accord—but only with the help of a good deal of complicated and expensive apparatus. The mercury vapour rectifier lends itself more readily to automatic control. Some twenty years ago a distinguished foreign electrical engineer, M. Leblanc, made the statement that so far as epoch-making inventions were concerned, the electro-magnetic principle was played out, and that attention must be paid to the vacuum tube. Since that time there has been considerable progress in the development of static converting plant, which, however, is not nearly so cheap as might be imagined. If the manufacturers could reduce the price they would undoubtedly secure a very substantial market for their apparatus. Rectifiers have, of course, certain disadvantages. When they are used for traction purposes, for example, regeneration is out of the question, but up to the present regeneration has not aroused much enthusiasm in this country. Far-seeing engineers prophesy that the valve will eventually play a great part in electrical engineering. Dr. Hull, of America, is reported to have said that the valve will eventually be installed on electric locomotives, either for rectifying high voltage alternating current or for changing high-pressure direct-current collected from the overhead line into alternating current, which might have its frequency varied to give different speeds. The same authority has shown how it might be possible with the aid of twelve magnetron valves of quite moderate dimensions to transform 60,000 kilowatts at a direct-current pressure of 100,000 volts, into single-phase alternating current at any desired voltage, with an efficiency of 96 per cent. This and other proposals may or may not take a long time to materialise, but the fact remains that such schemes are within the range of possibility, and our manufacturers would be well advised to bear in mind that converting machines of all types will in all probability eventually give place to static apparatus.

Literature.

Brassey's Naval and Shipping Annual, 1926. Edited by Sir ALEX. RICHARDSON and ARCHIBALD HURD. Wm. Clowes and Sons. 25s. net.

THE influence of the Washington Treaty on international naval policies, and the effect of the rivalry between oil and steam engines on the economy of merchant shipping, furnish the twin themes to which the new edition of this famous annual is chiefly devoted. The Editors have been fortunate in securing a series of authoritative papers on these and co-related topics of interest to the maritime world. Commander C. N. Robinson, R.N., surveys with his customary breadth of knowledge the progress of the Imperial naval forces during the past twelve months. Owing to the official policy of secrecy now in force, he is unable to offer any further particulars of new construction. He notes, however, that the adoption of higher steam pressures for the Parsons' marine turbine, with a consequent reduction in fuel consumption and engine-room weights, may simplify the problem of employing to best advantage the 35,000 tons of displacement to which future capital ships are limited by the Washington covenant. This year, for the first time, foreign naval progress is discussed by the same capable pen. The trend of American policy is clearly indicated by excerpts from recent official reports, and the Hawaiian manœuvres of last summer are briefly described. Japanese activity in naval construction is revealed in tabular form; it is directed mainly to the creation of a large fleet of cruisers and other light craft. Developments in France, Italy, and the lesser naval States also receive attention. In their examination of comparative strength, the Editors remark upon the smaller cruising fleets which are now in service or under construction, as compared with the pre-war establishments. Wastage due to obsolescence is being only partially made good, except in the case of Japan, who is replacing ship for ship.

Lord Jellicoe has a weighty chapter on Imperial naval policy, in which, after revealing the dependence of the British Commonwealth on ocean trade and dwelling on the urgent need of adequate naval protection, he submits a well considered scheme for distributing the financial burden of defence more equably than at present. In view of the Admiral's experience and the personal esteem in which he is held by our kinsmen overseas, his appeal can scarcely fail to make an impression in the Dominions. Sir George Thurston breaks new ground this year with a proposal to amalgamate the battleship and aircraft-carrier in one type of ship, capable of performing the functions of each. This could be done, he thinks, without infringing the terms of the Treaty. Such a ship is suggested as a more profitable investment for a minor Naval Power than a conventional battleship. His design is for a vessel of 28,000 tons, 750ft. long by 88ft., with a sea speed of 26½ knots. She would be armed with six 16in. guns in triple turrets at the bow, and ten 4.7in. A.A. guns. Ample deck space would be left free for the departure and landing of thirty aeroplanes, stowage and maintenance facilities for this contingent of aircraft being allowed for in the design. Boiler smoke would be discharged overside through water-swept horizontal ducts. Provision is made for reasonable protection above and below the surface. If nine 12in. guns were substituted for the six heavier pieces, the displacement could be reduced. This paper is of great technical interest, and will certainly provoke discussion in naval circles here and elsewhere.

In a chapter on Washington Conference results, Admiral Niblack, U.S.N., discusses very frankly the naval aims of the great Powers, and has much of interest to say about recent improvements in ship

design, gunnery and aviation. The conclusion he comes to is that gunfire remains the determining factor in sea warfare, despite the admitted potency of submarines and aircraft. A contrary opinion is advanced by Commandante V. de Feo, of the Italian Navy, who proclaims the supremacy of the submarine, but is not satisfied with existing designs. He thinks it is feasible, by resorting to a shorter pressure hull, so to improve the metacentric height as to enable far heavier weights to be carried on a given displacement. A 3000-ton boat built on this system would, it is claimed, be able to mount four 8in. guns.

In the Merchant Shipping Section, which occupies half the book, the position of the world's commercial fleets is examined, as in previous editions, by the Chief Ship Surveyor of Lloyd's Register. Sir Westcott Abell finds the outlook far from encouraging. There is a marked excess of shipping over present requirements, and no prospect of an increased demand for transport that would absorb this surplus. A drastic pruning of unwanted tonnage is required to restore the shipping trade to a condition of health and efficiency. Mr. James Richardson deals again with marine engineering. He shows that this year, for the first time, the gross tonnage of motor ships building definitely exceeds that of the steamers under construction, though in Great Britain the percentage of motor tonnage is far below the figure for other countries. Both in this article and in one by Mr. C. Maughan, the important question of motor ship operating costs is ventilated.

Other timely and informative articles have been brought together in the Mercantile Section. The usual plans and profiles of men-of-war and merchantmen, official documents relating to naval matters, and copious appendices round off a volume which no one who desires to keep abreast of naval and maritime affairs in general can afford to be without. The illustrations this year are of singular merit, while a detachable large-scale chart of the world, showing the principal routes of navigation, constitutes a new and valuable feature.

Jane's Fighting Ships, 1925. Edited by OSCAR PARKES and F. E. MCMURTRIE. Sampson Low. 42s. net.

AT the present time there are something like 3000 men-of-war and naval auxiliaries in service under various flags, and with few exceptions they are illustrated and described in the 1925 edition of "Fighting Ships." Not without reason, therefore, do the publishers introduce the volume as "the only complete and authentic encyclopædia of all the navies of the world." To keep a periodical of this kind reasonably up to date demands unremitting vigilance and constant labour on the part of the editors. This year, as previously, they have performed their arduous task with signal success. Warships are not exempt from the capricious dictates of fashion. In the course of her relatively brief career the modern man-of-war may assume half-a-dozen different guises. Her funnels and masts may be raised or abbreviated or suppressed altogether, her gun positions be transposed, or her entire appearance be altered by thorough reconstruction. It follows, therefore, that a photograph of the ship taken last year might convey a totally misleading impression of her aspect to-day. This is literally true in the case of many existing warships, and it serves to explain the peculiar difficulties which beset the compilation of an Annual which aspires to give an accurate view of every combatant ship afloat. In the present edition fewer changes are observable in the British section than in the pages devoted to foreign fleets.

Unofficial plans of the "Nelson" class and the minelayer Adventure are inserted, but are not claimed as authentic. Completed ships are illustrated for the most part by the help of photographs taken during the current year, both their broadside and end-on appearance being shown. Two magnificent views of the Hood and the Repulse deserve special mention. Aircraft carriers now take up a great deal of space, the latest vessels of this type being the rebuilt Furious, which the uninitiated might well mistake for a modern version of Noah's Ark. Among the new cruisers illustrated are the Effingham and Emerald. The Enterprise, a sister ship to the last-named, will differ from her consort by having the forward 6in. guns twin mounted in a closed turret. Destroyers and submarines are carefully classified, and there are two striking views of the monster X 1.

Delays in the French building programme are responsible for the omission of engravings of the new ships which our cross-Channel neighbours are constructing in such large numbers; but a launch view of the big destroyer Bourrasque is included, and there are revised plans of the 8000 and 10,000-ton cruisers. The German Navy section has been entirely re-illustrated. Most of its units have undergone extensive modification, their new appearance now being displayed for the first time. The Italian section has also been brought pictorially up to date. Some very unconventional craft are depicted in the Japanese pages. The battleship Mutsu, completed as recently as four years ago, has already been reconstructed, and her outline entirely altered by the odd curvature of the first funnel, which is now set well back from the bridge. Aesthetically it is a change for the worse, but in modern warship practice the claims of utility are paramount. Another grotesque vessel is the cruiser Yubari, in which an attempt has been made to combine heavy armament and great speed on a displacement of only 3000 tons. Excellent views of the aircraft carrier Hosho have at length been secured. All the other navies, great and small, receive adequate treatment, for it is a sound tradition of "Jane" that the minor fleets shall be given the same proportionate attention as the more imposing armadas of the major Powers. Recognition silhouttes of a new type have been tentatively introduced this year, and, if generally approved, will gradually replace the block profiles which have done duty up to now. In our opinion, the new drawings are a distinct improvement; they bring out small points of detail that a black silhouette cannot show, but which are of value in assisting the identification of individual ships whether at long or short range. The new edition of "Fighting Ships" is admirable for the number and quality of the illustrations, the reliability of the ships' data, and its general make-up, all of which reflect great credit on the editorial staff.

BOOKS RECEIVED.

Turbines Hydrauliques. By A. Rateau, D. Eydoux and M. Gariel. Paris: J. B. Baillière et Fils, 19, Rue Hautefeuille.

Volatile Solvents and Thinners. By Noël Heaton. London: Ernest Benn, Ltd., 8, Bouverie-street, E.C. 4. Price 15s. net.

The Mechanical World Year Book, 1926. London: Emmott and Co., Ltd., 20, Bedford-street, W.C. 2. Price 1s. 6d. net.

Statik der Bodenkonstruktion. By Dr.-Ing. W. Schilling. Berlin: Julius Springer, Linkstrasse 23-24, W. 9. Price 15 G marks net.

Wassermessungen bei Wasserkraftanlagen. By Dr.-Ing. L. A. Ott. Munich: Richard Pflaum.

E. T. Busk: A Pioneer in Flight. By Mary Busk. London: John Murray, 50A, Albemarle-street, W. 1. Price 7s. 6d. net.

Jahrbuch der Brennkrafttechnischen Gesellschaft E.V. Vol. V. 1924. Halle (Saale): Wilhelm Knapp, Price 7.80 gold marks.

Principles of Machine Design. By C. Norman. London: Macmillan and Company, Ltd., St. Martin-street, W.C. Price 28s. net.

Theory of Structures. By H. W. Coultas. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 15s. net.

The South American Hand-book, 1926. London: South American Publications, Ltd., Atlantic House, Moorgate, E.C. 2. Price 7s. 6d. net.

Technical Education: Its Development and Aims. By C. T. Mills. London: Edward Arnold and Co., 41, Maddox-street, W. 1. Price 6s. net.

Das Deutsche Patentrecht. By Dr. F. Damme and R. Lutter. Berlin: Otto Lubmann, Potsdamer str. 96, W. 57. Price 28 marks net.

The Chemistry of Drying Oils. By R. S. Morrell and H. R. Wood. London: Ernest Benn, Ltd, 8, Bouverie-street, E.C. 4. Price 21s. net.

Physical Metallography. By E. Heyn and M. A. Grossmann. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 30s. net.

Practical Road Engineering. By H. E. Goldsmith. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 25s. net.

Modern Railway Signalling. By M. G. Tweedie and T. S. Lascelles. London: Blackie and Son, Ltd., 50, Old Bailey, E.C. 4. Price 20s. net.

Plastic Magnesia. By O. C. Ralston, R. D. Pike, and L. H. Duschak. Washington: Government Printing Office, D.C., U.S.A. Price 30 cents net.

An Introduction to Industrial Administration. By John Lee. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

Metallurgy and its Influence on Modern Progress. By Sir Robert A. Hadfield. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

Hütte des Ingenieurs Taschenbuch. Vol. I. Twenty-fifth Jubilee Edition. Berlin: Wilhelm Ernst and Sohn, Wilhelmstrasse 90, W. 66. Price 15.90 R. marks.

Colliery Working and Management. By H. F. Bulman and Sir R. A. S. Redmayne. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 42s. net.

Annales des Travaux Publics de Belgique, Septante-Huitième année, deuxième série. Tome XXVI. 5e Fascicule. Octobre, 1925. Brussels: Goemaere, 21, Rue de la Limite.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. VI. By J. W. Mellor. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price £3 3s. net.

Studies in Repetitive Work with Special Reference to Rest Pauses. By S. Wyatt and J. A. Fraser. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

Proceedings of the Fourth International Congress of Refrigeration. Two volumes. London: Organising Offices of the Fourth International Congress of Refrigeration, 22, Basinghall-street, E.C. 2. Price 45s. net.

Oil Field Exploration and Development. Vol. I., *Oil Field Principles;* Vol. II., *Oil Field Practice.* By A. Beeby Thompson. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price £3 3s. per volume or £6 6s. the pair.

Obituary.

WILLIAM MYERS.

THE death occurred very suddenly on Monday last of Professor William Myers, M.Sc. Tech., of the Manchester College of Technology. Professor Myers was formerly and for many years Director of Weaving in the College, having joined the staff in 1892, and was recently appointed to the Chair of Textile Technology, in succession to Professor F. P. Slater, who resigned. Professor Myers was very widely known and highly respected in the textile world. He had a long experience of the teaching of textile subjects, for prior to going to Manchester he held appointments at the Bolton and Darwen technical schools. Before taking up the teaching profession he had a varied and practical experience in the Lancashire textile industry.

To Professor Myers can be attributed very largely the responsibility for the development of the textile department in this College, which has been freely copied by other educational authorities. His intimate knowledge of the industry and of the mechanical equipment which this involves brought him into close contact with textile engineers. He was also a director of the Bolton Foundry Company, and played a very prominent part in the formation of the Society of Textile Industries. There was something exceptional in the sympathetic understanding of the needs of his students which fitted him for the teaching profession. He had a frank and genial personality, which made him *persona grata* with everybody with whom he came into contact. He was the author of works on Textile Testing and Costing, and a City and Guilds Medallist in Cotton Weaving and Woollen and Worsted Manufacture.

SIXTY YEARS AGO.

WHY do agricultural implement makers bedeck their products with colours which for brilliance and contrast are unmatched in the whole field of engineering? The question is as apposite to the practice of the present day as it was when, sixty years ago, we sought to answer it in our issue of December 15th, 1865. We had been to the Smithfield Club Show at Islington, and had come away disappointed with the exhibits. In their glossy highly-coloured coats the machines, engines and implements looked well, and, in many cases, deserved to rank as works of high art. But we felt that for all the novelty displayed the Show might well have been that of 1864 after a year's sojourn in the Agricultural Hall under lock and key. As for the paint, we expressed the view that the agricultural mind was perhaps sufficiently uneducated to be led away by the pleasures of the eye, and we had no doubt that many sales were effected by the judicious use of colour laid on with the intention of producing a pictorial effect. Yet vermillion and mud were inimical to each other. Lovely greens and brilliant varnish would not last long on a clay headland. We earnestly besought manufacturers to exhibit their products unpainted and unlagged, just, in fact, in the form in which they left the erecting shop. Were such a course followed it would be possible to judge of the merits or demerits of workmanship and to give a word of approval that would be really valuable. As things were, excellence of workmanship other than that of the painter and decorator went for very little. Without the paint the farmers might be as much in the dark as with it, but the judges, by whose awards the farmers were largely influenced, would be placed in a position to know all about the machinery on which they were expected to report. A few special prizes awarded for workmanship and material would go far to redeem the agricultural engineer from the thraldom of the paint brush, under which he was rapidly subsiding without a murmur. To-day the mechanical education of the farmer has proceeded so far that we can no longer believe that he is primarily impressed by outward appearances in the machines which he buys. Yet the implement maker is as strongly addicted to the use of brilliant paint as ever he was. Whatever was true in 1865 we cannot bring ourselves to the view that the paint is applied to hide defects. We prefer to seek an explanation of the continuance of the practice in the force of tradition, a tradition broken during the war but resumed at the earliest possible moment after it was over.

QUITE a considerable amount of mineral traffic is still hauled by gravitational inclines on the North-Eastern section of the London and North-Eastern Railway, and in order to carry the "timber dog" that keeps the cables in position on curves, the wagons have been fitted with what are known as hanging buffers. The latter also served as buffers for the chaldron wagons, but the latter are now obsolete. The hanging buffers could therefore be dispensed with were the necessity for the timber dog removed. The only apparent way to do that would be the expensive one of straightening the curves. It is stated in the current issue of the *North-Eastern and Scottish Magazine* that, to meet this difficulty, the company will require to spend several thousand pounds in straightening the curves on these inclines, unless some inventive mind can produce some cheaper alternative for meeting the difficulty. It is understood that the company is prepared to offer as a reward £100 for any satisfactory alternative invention put forward and adopted which will have the effect of saving the outlay on the alteration of the permanent way. Suggestions, with full particulars, should, it is stated, be forwarded to the divisional general manager, North-Eastern Area, L.N.E.R., York.

New Boiler Equipment at the Hell Gate Power Station, New York.

By JOHN R. C. KERSHAW, F.I.C.

SOME remarkable figures have been published recently of the performance of the boilers and stokers at the Hell Gate Super-power Station, New York. They are of considerable interest to engineers in this country, for they indicate that mechanical stoker equipment of the latest design, when combined with modern furnace construction, can produce results equal to those obtained with coal dust firing. Stated briefly, the official tests at Hell Gate for two runs with the new equipment, lasting twenty-five and twenty-eight hours respectively, showed overall efficiencies for the boilers, superheaters and economisers of 89.6 per cent. and 92.7 per cent., and only .4 per cent. of unconsumed fuel was present in the discharged ash. These tests were carried out with slack, containing an average of 3.17 per cent. moisture and 7.1 per cent. ash, with 18 per cent. to 20 per cent. of volatile matter, and testing 14,135 B.Th.U. as fired.

The significance of these figures lies in the fact that they prove that efficiencies of 90 per cent. and over are obtainable with mechanical stokers and ordinary slack or coal, without any previous drying or grinding. These latest published official tests will now have to be used in all future comparisons of the efficiency of systems of firing.

As no detailed description of the plant and equipment of the Hell Gate station has appeared hitherto in THE ENGINEER, a general description of the station, with all the details that are available relating to the stokers and furnace design is given below, since it is these features which have enabled these remarkably high efficiencies to be attained.

The station is situated close to Hell Gate Bridge on the Bronx shore of the East River, New York. Work was only started on the superstructure in February, 1921; but the erection of the station and its equipment was carried out so expeditiously that nine months later the first unit was already running, and by February, 1923, a monthly output of 40,000,000 kilowatt-hours had been attained. A bird's-eye view of the station, taken from an aeroplane during the present year, is shown in Fig. 1, page 670. The system of grouping adopted for the boiler and generator houses divides the plant into four groups of 75,000 kilowatts, or 100,000 kilowatts capacity. This plan simplifies considerably the lay-out of the steam pipes and air ducts and leads to considerable economies both in capital and running expenses. Each group consists of six boilers served by a separate smoke stack, and of two turbo-generators of 35,000, 40,000, or 50,000 kilowatts capacity. The ultimate capacity of the station when completed will be 335,000 kilowatts generated by eight turbines and twenty-four boilers. Five of the turbines and fifteen boilers are now in operation, so that it is probable the station will be finally completed in 1926 or 1927.

The boilers—see Fig. 5—are of the Springfield cross-drum sectional water-tube type and are run under normal conditions at 275 lb. steam pressure. The total temperature of the steam after superheating is 607 deg. Fah., which is equal to 180 deg. of superheat. The twelve boilers first installed were twenty tubes high, with a superheater placed in an interdeck position. There were consequently only six rows of tubes between the superheater and the furnace. Each of these boilers possessed 18,900 square feet of evaporating surface and 2135 square feet of superheating surface, and in order to avoid the use of economisers the tubes were arranged in banks fifty-four wide and twenty high. The lowest bank of tubes was 16ft. from the floor at one end and 21ft. at the other. Forced draught ducts ran along both sides of each row of boilers and were connected to a single large duct running the whole length of the boiler-house. The boilers were fired from both sides by fourteen retort underfeed stokers of the Taylor type. Each of these stokers was provided with seventeen tuyeres along the retort length, and a double-roll rotary ash discharge was placed in the angle formed by the dump plates between the two stokers. The furnace width from side wall to side wall was 24ft. 9in., and the depth between the two end walls was 19ft. The combustion space of the boiler was about 8000 cubic feet, which gives a ratio of 0.42 to 1 in relation to the heating surface of the boiler.

Three new boilers were erected to provide steam for a new 40,000-kilowatt generator about a year ago. They differ from the original boilers, both in the design and arrangement of the furnaces and in the plans for baffling and superheating. The side walls of the new furnaces consist of water tubes arranged vertically, with welded fins filling the spaces between, the lower part of the tubes being covered with fire-clay tiles for a short distance above the stoker mechanism. A paper upon this form of construction was read by H. D. Savage before the American Society of Mechanical Engineers on January 14th, 1925. An abstract of this paper appeared in the issue of THE ENGINEER for July 31st, 1925, so that it is unnecessary to describe the water-cooled furnace construction more fully in this article. Figs. 3 and 4 show the difference, however, between the old and new types of boiler setting and furnace construction at the Hell Gate station.

The new design of the Taylor stoker is illustrated in Figs. 4 and 6. Its main features are the more exact feeding throughout every portion of the retort and the more effective self-cleaning of every portion of the fuel bed. This leads to the possibility of much higher fuel burning rates per unit of furnace area, and in recent tests during an eleven-hour run an average rating of 460 per cent. was attained, with a maximum of 603 per cent. during a shorter period. Outside the furnace the stoker has been radically strengthened both in its stationary and in its moving parts, and the drive is of an entirely new type, which is stated to be more efficient than the older one and less costly in repairs and maintenance. The new stokers are the same width and are provided with fourteen retorts as before, but only one stoker, thirty-three tuyeres in length, is provided for each boiler, in place of the two with seventeen tuyeres each, and the depth between the furnace end walls is reduced to 15ft. 6in. in place of the 19ft. of the earlier design.

The stokers are operated by low-pressure forced draught and the furnace pressure is controlled by a balanced draught equipment, which automaticaly reduces the speed of the induced draught fans according to the requirements of the fuel bed.

The three chimney stacks shown in the aerial view of the station in Fig. 1 carry off the waste gases from each group of six boilers and rise to a height of 258ft. above the firing floor. They have an internal diameter of 21ft. and are provided just below the breeching with a cinder-catching chamber, in which the gases are deflected by a baffle as they rise and deposit the larger particles of ash and cinders in a tank of water. Each group of six boilers is equipped with four forced draught and with one induced draught fans, these fans being driven by brush-shifting G.E.C. 200 horse-power direct connected motors. The fans havd capacities of 120,000 cubic feet and 140,000 cubic feet of air per minute at 6in. or 7in. pressure.

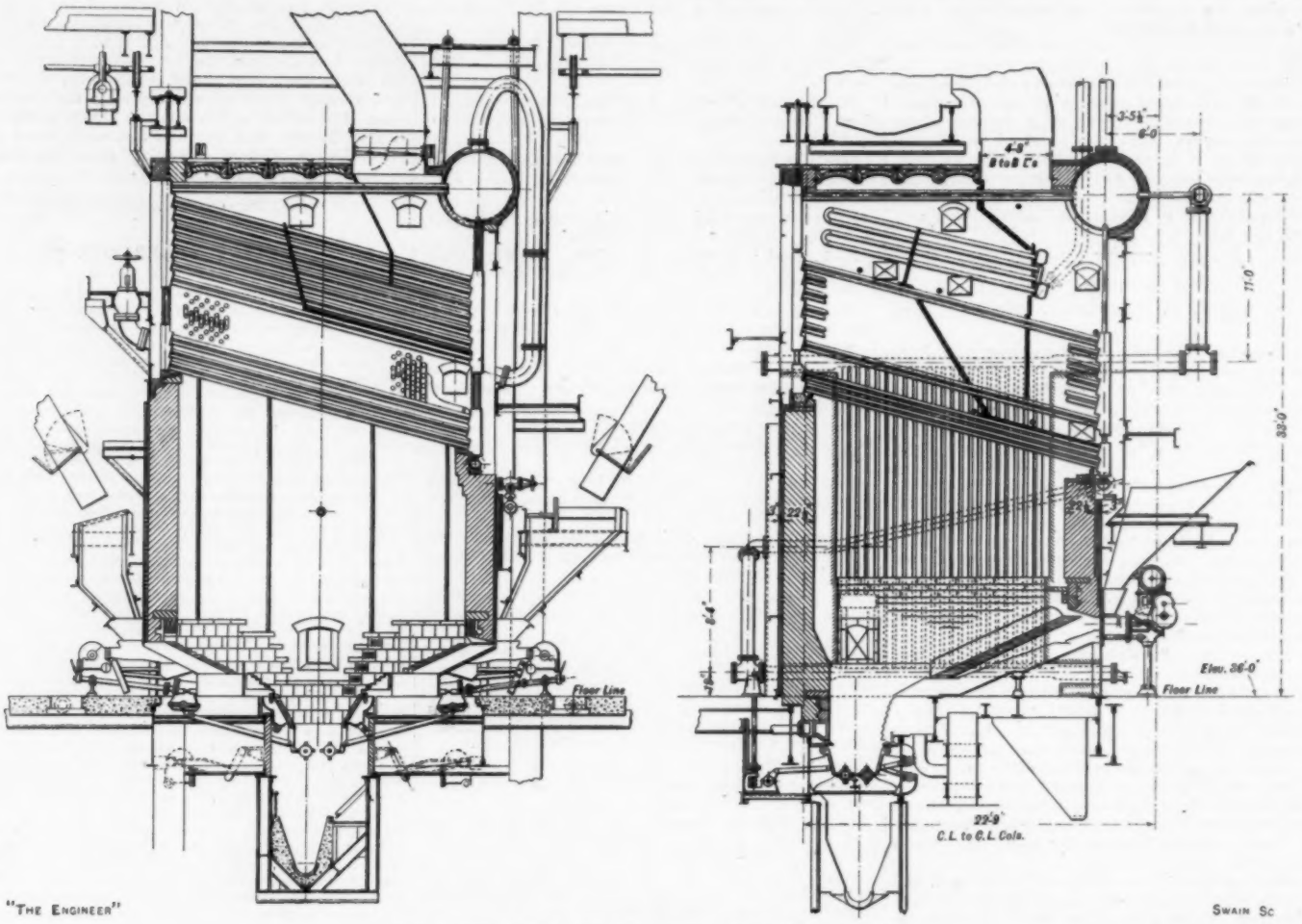
The clinker and ash are removed by an hydraulic sluicing system as they pass through double-roll clinker grinders. They fall into an inclined smooth-tiled concrete trough which runs under each group of boilers, and are carried away by the constantly flowing stream of water. The discharge trough from each six boilers is connected to a main discharge trough lined as before with smooth tiles, which carries the ash and clinker into a concrete-lined pit situated on the East River side of the power-house. From this pit the ashes and clinker are removed periodically by a clam-shell perforated bucket operated by a gantry crane and are discharged into barges or motor trucks. The capacity of this ash sluicing system, when the station is finally completed, will be 25 tons per hour, and the water required will be supplied by six centrifugal pumps driven by six 125 horse-power squirrel-cage motors. The water required will amount to 5000 gallons per minute and will be obtained from the East River.

Two turbo-generators, as already stated, are connected to each group of six boilers and form one unit of the station equipment. The two earlier groups were made up of one 35,000-kilowatt, 25-cycle, G.E.C. Curtis type horizontal single-cylinder turbine running at 1500 revolutions per minute, and one 40,000-kilowatt, 60-cycle, Westinghouse semi-double-flow, Parsons type tandem turbine, running at 1200 revolutions per minute and operating under the same steam pressure and vacuum as the Curtis machine. The guaranteed steam consumption for these turbines was as follows:—

Curtis turbines.		Parsons turbines.	
Output in K.W.	Lb. per K.W. hour.	Output in K.W.	Lb. per K.W. hour.
20,000	10·85	15,000	11·15
27,500	10·30	20,000	10·75
35,000	10·65	28,000	10·40
		35,000	10·65
		40,000	10·90

The turbines in the two first groups are bled at two points, namely, at 6½ lb. absolute pressure and at a little above atmospheric pressure, in order to provide the steam for the closed heaters and also steam for the open heaters, when required. Each main unit is also provided with a self-contained oil system, consisting of pumps, oil filters and oil coolers, and the heat of the cooling water from this system is recovered for the boiler feed. This feed water is therefore heated successively by (1) steam bled from the main turbines at 6½ lb. absolute pressure, (2) hot water from the oil coolers and from the air ejector condensers, (3) condensate from the gland packings, (4) exhaust steam from the house turbine.

The temperature of the feed is maintained at 210 deg.



FIGS. 3 AND 4—OLD AND NEW TYPES OF BOILER SETTING

THE HELL GATE ELECTRIC GENERATING STATION, BOILER PLANT

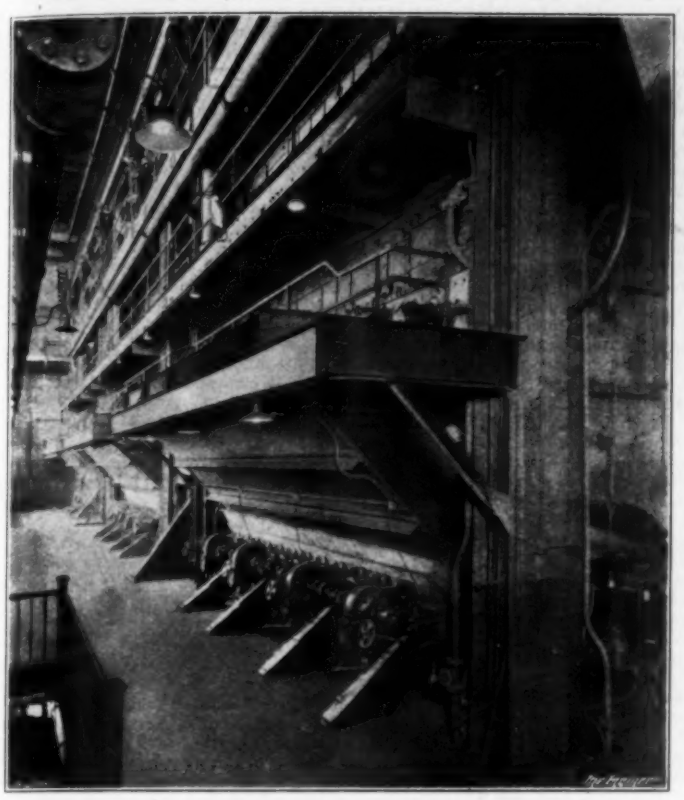


FIG. 5—MAIN FIRING AISLE OF THE SPRINGFIELD BOILERS

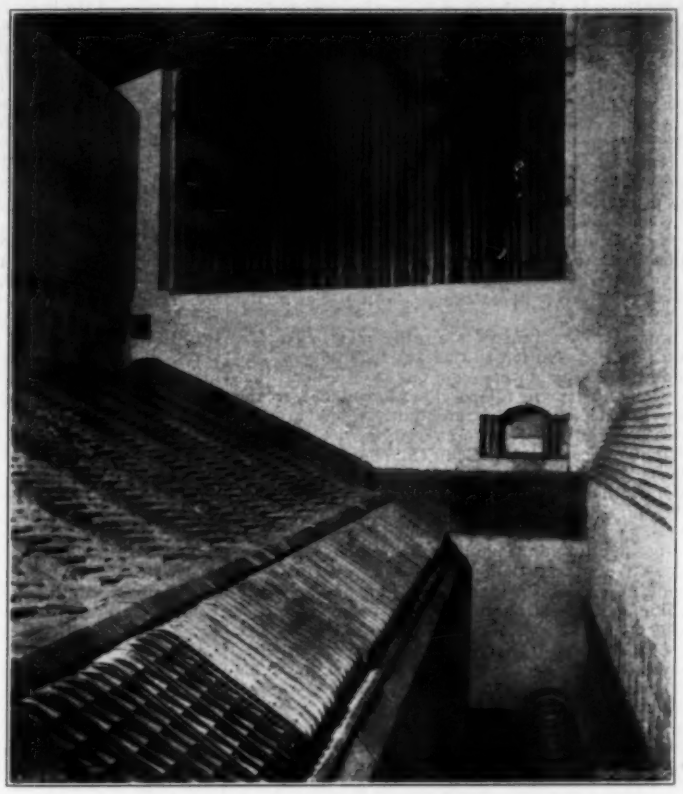


FIG. 6—INTERIOR OF BOILER FURNACE SHOWING TAYLOR STOKER

Fab. by varying the auxiliary load carried by the house turbine.

Each main unit exhausts to a 50,000 square feet surface condenser, the Westinghouse turbine being connected to a Westinghouse condenser, and the Curtis turbine to a Worthington condenser. Moulded rubber expansion joints, elliptical in shape and ⅛in. thickness, are used for the Westinghouse condenser, the end of these moulded rubber connections being beaded and fitted on with clamps to the turbine and condenser in order to make a tight joint. The G.E.C. Curtis turbine, on the other hand, is connected rigidly to the Worthington condenser, which is supported on springs, in order to take up the expansion. The Westinghouse and Worthington condensers are provided each with 10,050 1in. tubes, 19ft. in length, and No. 18 B.W.S. Admiralty mixture. The water boxes are divided vertically in order to facilitate cleaning and repairs, and a pump delivering 35,000 gallons per minute provides circulating water for each side of the condenser. All piping is connected to the condensers by rubber expansion joints, and any salt water leakage into the condensate is detected by an electrical method, a low-range ammeter being used to show any increase in electrical conductivity which follows from this cause. The cooling water for the condensers is drawn from the East River through two 54in. pipes and is discharged again into a tunnel running parallel with the river bank through two pipes of the same size. When the equipment of the station is completed the cooling water required will amount to 800,000,000 gallons per day, or more than the total daily requirements of the whole city of New York.

Details of the new turbo-generators and auxiliary equipment for the No. 3 unit are not yet available, but Fig. 2 is reproduced from a photograph of the 50,000-kilowatt cross compound Westinghouse Parsons type machine which has recently been put into operation.

In conclusion, the details of the two tests referred to in the introduction of this article may be given here.

General.

Boiler heating surface, including area of side wall, tubes and fins exposed to furnace	15,900 sq. ft.
Superheater surface	7,430 sq. ft.
Economiser surface	13,824 sq. ft.
Grate surface	378 sq. ft.
Furnace volume	8,000 cu. ft.

	Test No. 3.	Test No. 5.	Maximum rating test.
Duration of tests, hours	25	28	1
Coal fired per hour as received, lb.	7,633	8,133	—
Actual water evaporated per hour, lb.	87,750	88,221	265,000
Equiv. water evaporated per hour, boiler and superheater, lb.	93,278	99,355	289,000
Equiv. water evaporated per hour, boiler, superheater, and economiser, lb.	103,809	106,003	308,275
Quality of saturated steam, per cent.	98·75	98·89	98·10
Pressure in drum (gauge), lb.	267	266	280
Pressure in superheater outlet, lb.	263	263	244

Temperatures.

	Deg. Fah.	Deg. Fah.	Deg. Fah.
Feed water entering economiser	205	128·2	165
Feed water entering boiler	285	233·1	267
Boiler-room	65	81	—
Air for combustion	58	65	—
Flue gases leaving boiler	455	485	660
Flue gases leaving economiser	229	193	336
Superheat	547	565·3	563

Draught.

	Inches.	Inches.	Inches.
Drop through boiler and superheater	0·45	0·50	3·27
Drop through economiser	0·21	0·27	2·00
Total draught loss	0·66	0·77	5·27
Forced draught pressure in wind-box	1·16	1·85	6·00

Efficiency and Capacity.

Horse-power developed by boiler and superheater	2703	2879	8390
Rating developed by boiler and superheater, per cent.	170	181	528
Combined efficiency of boiler, superheater, and economiser, per cent.	89·6	92·7	—

Ash Analysis.

	Per cent.	Per cent.
Combustible in refuse	4·50	4·44
Refuse percentage of coal fired	7·46	7·80

Heat Balance.

	Hot water test No. 3. B.Th.U.	%	Cold water test No. 5. B.Th.U.	%
Heat per lb. of dry coal	14,626	100	14,563	100
Heat abs. by water and steam in boiler and superheater	12,153·1	83·2	12,322·1	84·6
Heat abs. by water in economiser	956·0	6·5	1,183·2	8·1
Heat loss due to moisture in coal	29·7	0·2	43·7	0·3
Heat loss due to water from combustion of hydrogen	470·9	3·2	116·7	3·1
Heat loss due to moisture in air	3·4	0·0	2·5	0·0
Heat loss due to dry chimney gases	739·2	5·1	460·4	3·2
Heat loss due to incomplete combustion of carbon	30·4	0·2	20·7	0·1
Heat loss due to unconsumed combustible in refuse	62·8	0·4	52·6	0·4
Heat loss due to unconsumed hydrogen hydro-carbon radiation and unaccounted for	181·0	1·2	31·1	0·2
		100·0		100·0

Flue Gas Analysis.

	Test No. 3. Leaving boiler.	Leaving economiser.	Test No. 5. Leaving boiler.	Leaving economiser.
CO_2, per cent.	11·60	10·91	13·04	12·01
O, per cent.	7·52	8·45	6·25	7·28
CO, per cent.	0·06	0·04	0·04	0·03
Lb. of gas per lb. of coal	17·55	18·78	15·83	17·13
Per cent. of excess air	60·1	71·6	38·4	49·7

Proximate Coal Analysis.

	Test No. 3.	Test No. 5.
Moisture, per cent.	2·55	3·80
Volatile matter, per cent.	20·00	18·85
Fixed carbon, per cent.	70·42	70·19
Ash, per cent.	7·03	7·16
Sulphur	·67	·77
Fusion temperature, deg. Fah.	2,440	2,450
As fired, B.Th.U.	14,261	14,010
Dry, B.Th.U.	14,626	14,563
Combustible, B.Th.U.	15,760	15,734

The fuel consumption per kilowatt-hour generated at Hell Gate has continuously decreased since the station was started in 1923. From a monthly average of 1.265 lb. it dropped to 1.18 lb. for the month of June, 1925, and the engineers of the station are confident that a still lower figure will be ultimately obtained. This figure of 1.18 lb., it may be stated, was obtained with a station output of 82,200,000 kilowatt-hours, a maximum load of 189,000 kilowatts, and a thermal efficiency of 20.45 per cent. for the whole month.

The writer's thanks are due to H. W. Leitch, the General Superintendent of the Power Plant of the United Electric Light and Power Company, of New York, and to the Chief Engineer of the American Engineering Company, of Philadelphia, for the photographs and other illustrations, and for the operating data, used in this article.

The Public Works, Roads and Transport Exhibition.

No. IV.*

THERE were so many things of interest shown at the recent Public Works, Roads and Transport Exhibition that we have still to complete our review of them, and now do so in what follows.

The increase in the use of tar and bituminous asphalt for road construction has led to the introduction of many types of mixers, an important constituent part of which is the apparatus in which the stone is dried before being mixed with the binding material. The majority of the dryers employed are of the cylindrical revolving type, several of which we have described. An entirely different type was exhibited by Mr. Frederick Parker, of Leicester, who calls it his continuous-duct "Glider" dryer. Briefly described, this apparatus comprises a rectangular casing of steel plate, which contains a continuous duct made up of a series of inclined trays or channels arranged one above another in zig-zag fashion, so that material fed into the top tray may travel downwards from tray to tray, passing as it does so along the length of all the trays and being discharged in turn from the lower end of an upper tray into the top end of the tray immediately below it, until it reaches the outlet at the bottom.

A to-and-fro movement is given to all the trays simultaneously, and it is of such a character that the material being dried is made to travel gently from end to end of the trays. The height through which the material has to fall from tray to tray is small, and the maker attaches much importance to that fact and to the "gliding" motion of the material as it passes down the inclines. He points out that if the clean, sharp, crystalline surfaces of the broken stone chippings can be retained while they are being heated, the material binds infinitely better with the bitumen compound than would otherwise be the case, and he claims that his dryer does dry the stone without abrasion, very little dust, which may easily be separated from the stone, being made.

At the bottom of the casing is a furnace and at the

* No. III. appeared December 11th.

top there is a belt-driven eduction fan. The heated gases from the furnace travel along the same zig-zag path as does the material being dried, but, of course, in the reverse direction. An important feature of the machine is that the duct is totally enclosed, so that the gases and stone are brought thoroughly into contact one with the other. As the stone gets nearer and nearer to the exit, so the temperature of the gases meeting it becomes higher and higher. As it falls from one incline to another it gets automatically turned over, with the result that it is uniformly dried.

The temperature to which the stone is raised can be regulated in the following different ways:—(1) An adjustable damper is fitted at the inlet end of the duct; (2) the exit opening is fitted with drop fingers by which the cold air may be regulated; (3) the speed of oscillation of the duct is controlled by cone pulleys, and the ability to vary the rate of progress of the material through the dryer gives a definite control over the temperature of the material at the discharge.

In addition to the points already mentioned, Mr. Parker draws attention to the fact that there are no complicated mechanisms to get out of order, and that the wear and tear in the machine is confined to the bearings, excentric shafts and pins, which are, we understand, fitted with force-feed lubricators, and which in any case can be easily and cheaply replaced. Coke, coal or oil can be used as fuel, and it is believed that no other dryer of similar capacity requires so little power to drive it. The apparatus is mounted on wheels, so that it is portable, and it can be readily incorporated into an asphalt or bituminous macadam plant. We gather that these dryers are made to give outputs up to 200 tons per working day.

Of miscellaneous exhibits which caught our eye during our inspections, we may mention the following:

On the stand of W. and J. Glossop, of Hipperholme, Halifax, we saw two types of tar or bitumen-spraying machines, and a "Powrcleer" pipe-cleaning apparatus, with sections of pipes both highly encrusted and after the encrustation had been removed by the apparatus. Bernard Holland and Co., of 17, Victoria-street, Westminster, S.W. 1, had several portable air-compressing plants, among them a mobile plant on a lorry chassis designed to deal with 180 cubic feet per minute. The Liner Concrete Machinery Company, of Newcastle-on-Tyne, was showing examples of its concrete block and stone-moulding machines, with which our readers are familiar, and also a "Liner" patented semi-dry concrete mixing machine. Tomlinson (Marylebone), Ltd., of 3, Finchley-road, St. John's Wood, London, N.W. 8, was displaying three types of Morris commercial cars—a 1-ton chassis fitted with a tipping body, a 1-ton chassis fitted with a dust-cart body, and a chassis adapted as a road sweeper. Walker Vehicles, Ltd., of Clare House, Kingsway, London, had on its stand a standard Walker electric tractor fitted with a "balance drive." The exhibit of Wm. Jones, 154–5, Upper Thames-street, London, E.C. 4, consisted mainly of light railway equipment and contractors' plant, &c., among which we saw a rebuilt and reconditioned 20 horse-power "Simplex" petrol tractor which looked exceedingly serviceable. Bitumen and tar-spraying machines were shown by the Phœnix Engineering Company, Ltd., of Chard, Somerset.

On the stand of Hadfields, Ltd., of Sheffield, we saw, amongst other things, a "Hecla" disc stone crusher, which has been somewhat modified in construction since is was described in our columns, and a 16in. by 5in. granulator. Developments of the tamping machine and concrete breaker, which was exhibited two years ago by B. Johnson and Son, of Wharfedene, Ilkley, Yorks, and which were illustrated and described in our issue of February 29th, 1924, were shown in operation by the same firm. A particularly smart and workmanlike steam wagon was by itself on the stand of William Foster and Co., Ltd., of Lincoln. It was of from 5 to 6 tons capacity, and had a Belpaire fire-box. The wheels were rubber-tired, single for the front wheels and twin for the rear. As usual there was a reconditioned road roller on the stand of John Allen and Sons (Oxford), Ltd., of Cowley, Oxford, and very serviceable it looked too. Thomas Coleman and Sons, Ltd., of Alfreton-road, Derby, were exhibiting various sizes of their patented "Arch" boiler for heating tar, pitch or bitumen, and also their "Flapper" spraying machine and a new type of squeegee spreader.

On the stand of Goodwin, Barsby and Co., Ltd., of Leicester, there were, in addition to this firm's standard products, such as their "Acme" granulator, models of a new portable band conveyor or loader, and of the "Pyrus" cylindrical dryer. There were several types of bitumen-spraying machines on the stand of W. Weeks and Son, including a useful-looking little hand machine, known as the No. 4 H. Johnston Brothers, of 79, Mark-lane, E.C. 3, had their usual imposing exhibit, in its usual place, including an example of their 10-ton per hour asphalt plant. This plant, so we gathered, has been improved by having embodied in it a new drying and heating drum, and a new heated mixer. A new squeegee attachment has also been added to this firm's bitumen boiler.

In addition to exhibits of their products specially designed for sewers and sewage disposal, Tuke and Bell, Ltd., of Lichfield, had on view a general-purposes self-propelling vehicle on a "Morris" 1-ton chassis, which was fitted with a two-seated cab with a plate-glass wind screen and side doors. This vehicle has a capacity of 100 cubic feet for house refuse and of 41 cubic feet for general purpose haulage work. The top portion of the body is readily removable when it is not required. The house refuse body is fitted with low-loading doors, and sliding steel covers to prevent the contents from being blown about during transit. It is furnished with the firm's patented gravity hand-operated end-tipping gear, in which the arrangement is such that when the body is in its normal position it is held rigidly on the chassis, while for tipping it is moved to the rear until the point of overbalance is reached, when it tips to an angle of 45 deg., but is always under control.

On the stand of H. R. Marsden, Ltd., of Soho Foundry, Leeds, there were a 16in. by 9in. Blake-Marsden X type lever motion stone breaker and a 20in. by 5in. granulator, but both appeared to be of the firm's well-known design and to embody no particularly novel features. Davey, Paxman and Co., Ltd., of Colchester, exhibited one of their latest types of NacoPax plants for the preparation of material for synthetic asphalt roads. It was practically identical with the plant which was illustrated and described at considerable length in our issue of November 13th last. There was a very extensive display on the stand of the Ingersoll-Rand Company, Ltd., of 165, Queen Victoria-street, E.C. 4, of portable and stationary compressors and of pneumatic tools for use therewith, but they were all, so we gathered, of standard types which call for no special description.

The Aquatole Manufacturing Company, Ltd., showed examples of its endless chain pump, which, it is claimed, can lift any liquid or semi-liquid to any height. A number of workmanlike tools and apparatus was exhibited by Holman Brothers, Ltd., of Camborne. They included a petrol portable air compressor, compressed air hammers, spades, &c., and concrete breakers. Broom and Wade, Ltd., of High Wycombe, showed an interesting selection of their well-known portable and other air compressing plants, some of them in actual operation. Crossley Brothers, Ltd., of Bedford, had only two things on view, but both of them were interesting. One was a petrol-paraffin 5-ton locomotive, fitted with a 25 horse-power engine and built for a 2ft. gauge. This little engine is said to have a tractive effort of from 70 to 100 tons. The other exhibit was a launch driven by a paraffin-petrol engine and equipped with power-driven reciprocating knives for cutting water weeds in rivers, lakes, dykes, &c. It was propelled by a pair of paddle wheels which were movable about from side to side for steering purposes.

The stand of the Horstmann Gear Company, Ltd., of Newbridge Works, Bath, contained an extensive range of automatic lighting apparatus for public street lamps. Wm. Smith and Sons, of Barnard Castle, in addition to a tar-spraying machine and other vehicles, showed a roadman's living van fitted with accommodation for four men. It was mounted on springs and wrought iron wheels and had slag wool packed between the boards. It was complete with beds and bedding, cooking utensils, &c., and though a bit constricted, looked certainly very cosy. Bell Brothers (Manchester), Ltd., of Denton, Manchester, had on view a model of their water purification plant. The Sullivan Machinery Company, of 819, Salisbury House, London, E.C. 2, exhibited air compressors and tools for use therewith. Scavenging vehicles were shown by Wm. Ball and Sons, Ltd., of Rothwell, Northants. Hammer drills and other mining tools were exhibited by the Climax Rock Drill and Engineering Works, Ltd., of Carn Brae, Cornwall. Models of various types of dryers, screens, &c., which he makes, were on the stand of Mr. John F. Wake, of Darlington. Shelvoke and Drewry, Ltd., of New Icknield Way, Letchworth, Herts., showed models of their low-loading Freighter vehicles for municipal and general haulage purposes. A completely equipped Fageol safety coach, so called on account of its low loading line and width of track, was on the stand of Warwick Wright, Ltd., of 150, New Bond-street, London, W. The Gannow Engineering Company, Ltd., of 29, Victoria-buildings, Manchester, was, as usual, showing examples of its granulating and pulverising machines.

An interesting tar-spraying and road-brushing machine was exhibited by Mr. F. G. Barnes, of Godalming. In this machine there are three rows of brushes, 5in. wide and 6ft. long, which are each made up of three sections fitted with springs so that they may adapt themselves to the camber of the road surface. The brushes are given a reciprocating transverse motion. A "Muk" universal tipping lorry was shown by the Mannesman Motor Lorries Company, of 7, Queen Anne's-chambers, Westminster. The Paterson Engineering Company, Ltd., of Windsor House, Kingsway, London, W.C. 2, had on view an 8ft. diameter pressure filter, a chloronome and other apparatus for dealing with and measuring the flow of water. Two tank wagons, one fitted with heating coils, for carrying tar, and the other lined with ebonite, for transporting acids, &c., were shown by Charles Roberts and Co., Ltd., of Wakefield. Several Fordson tractors, equipped for various purposes, were exhibited by the Muir-Hill Service Equipment, Ltd., of Trafford Park, Manchester. Braham, Patterson and Benham, Ltd., showed a portable asphalt cooker, a bitumen boiler and a bitumen spraying machine. Examples of its "non-chokable" pump were on the stand of the Wallwin Company of Warwick. Parker, Winder and Achurch, Ltd., of Birmingham, exhibited their "Empire" mixers. Some well-made and serviceable-looking pipe cutters were shown by Weston, Shipley and Weston, Ltd., of Leicester. The stand of the Kennicott Water Softener Company, of Wolverhampton, was taken up with a water-softening plant and a chlorinating plant.

As might be expected, in an Exhibition of this kind there were numerous exhibits of materials and tools used in the making and repairing of roads. There were, in fact, too many for us even to give a list of them, for there were upwards of sixty. All kinds of stone, broken to form metalling, or shaped for kerbs or setts, were shown, and any number of different kinds of tar, asphalt, bitumen, &c. There were, too, many kinds of reinforcement, and several stands full of hand tools of various kinds. Cement companies were also represented. In fact, there were examples or samples of apparently anything and everything which could conceivably be required for road construction and maintenance, and the Exhibition as a whole was wonderfully complete and practical.

Institution of Mechanical Engineers

NORTH-WESTERN BRANCH.

AT a meeting of the North-Western Branch of this Institution, held at the Engineers' Club, Manchester, on Thursday, the 3rd inst., Mr. H. F. L. Orcutt, M.I. Mech. E., read an abstract of his paper on "The Characteristics and Uses of Ground Gears." Unfortunately, the attendance was adversely affected by bad weather, and the discussion suffered somewhat in consequence. Still, the members who did take part in the debate gave the author a number of points to answer. The discussion was opened by Professor Stoney, the chairman, who said that one of the most important advantages of grinding was that it enabled almost any materials to be used for gear wheels, irrespective of whether they distorted in hardening or not. He said that one of the greatest difficulties in connection with toothed gearing was that of mounting, especially in marine work, tramp steamers having given a good deal of trouble owing to the distortion of the foundation with the rolling of the ship affecting the gear case.

Mr. Newton, the next speaker, said that ground gears were destined to extend the use of this form of power transmission. While very much more expensive, size for size, than the ordinary cut gears, ground gears could be made smaller and lighter, so that the cost would actually be less. His knowledge of high-speed gears for marine work demonstrated that the noise increased with the load. On the subject of mounting, it seemed to him that with gears of the proportions used on motor cars, an error in parallelism of the shaft had small effect on the alignment of the teeth, because the distance between the bearings must be at least several times the face width of the teeth, whereas with larger powers demanding a considerable face width of teeth, any error in mounting was almost directly applicable to the teeth, thus accentuating stresses and reducing the permissible loads at which ground gears could be run.

Mr. Wright prophesied that the next ten years would witness a very great development in the use of ground gears. At high speeds the elasticity of the teeth became important, especially with high loads, but he thought that with ground gears the elasticity was probably able to absorb small inaccuracies. Mr. Orcutt had said that the degree of inaccuracy which they had found permissible was $^3/_{10000}$in. Mr. Wright asked in what form this inaccuracy might occur. Was it a question of indexing or deviation of form from the absolute involute? If it were a question of form, then he (the speaker) would suggest that there should be places where it was not harmful to have the $^3/_{10000}$in. as an excess and in other places as a deficiency. With regard to Mr. Orcutt's suggestion that machine tool builders would have to adopt ground gears, Mr. Wright said that one or two firms were already doing that, but at the present time the machine tool trade was not in a condition to adopt anything which would increase the prices of their products. But the trade would ultimately use ground gears.

Mr. C. W. Hunt said that hardened gears had come to stay. They meant longer service and fewer repairs, and if these advantages could be secured by grinding the gain would be great. With regard to electric traction gearing, railway gears gave out rapidly with very little wear. Experiments made in Switzerland on electric railways showed that as much as 166,000 miles was being got out of hardened pinions. One of the difficulties which they had to contend with was in the hardening of large gear wheels, and electric railways seemed to concern themselves chiefly with the hardening of pinions. He thought that experiments on the grinding of helical gear wheels would never have to be carried out, because before that stage was reached they would have perfected the grinding of spur teeth to such an extent that they would not need to trouble about any other forms.

Mr. Crook mentioned that there was a machine

available for grinding helical gears. Ground worm wheels were required for motor car steering gears, as the process of lapping to get easy steering was very expensive.

Mr. Heathcote was interested to know whether the true involute was the best tooth form. Possibly some slight alteration in form would give more silent running at high speeds.

Mr. Butterworth said he had tried to design a spur gear grinding machine. He considered that form of grinding was a step in the right direction from the production point of view.

Mr. Kersey said he had worked out the effect of the variation of 1 per cent. in the speed of gears during the time of contact, and had been astonished at the severity of the shocks that might ensue. He had taken two cases, one a gear wheel of thirty-five teeth, 8in. diameter, weighing 12 lb., and running at 2000 revolutions per minute. The variation of torque amounted to 7·3 foot-pounds. That would not appreciably affect the strength of the teeth, but at 1167 times per second it would produce an appreciable amount of noise in the gear-box. That, again, would have an effect on the other gears, as the torque would be transmitted along the shaft, and if the period of torsional oscillation of the sum of the gears happened to correspond it might accentuate an effect considerably. These stresses would be more important in turbine gears. Sufficient attention was not paid to the fact that very small changes in speed might involve very heavy stresses indeed.

Mr. Baggott said he had the opportunity of checking over many of the gears ground on Mr. Orcutt's machines, and could confirm that the inaccuracies, both in respect of the profile and general dimensions, were very fine indeed.

Mr. Dempster Smith said the author had chosen an angle of obliquity of action of 18 deg., but he (the speaker) was of the opinion that for a fifteen-tooth pinion an angle of obliquity of 20 deg. was necessary to avoid interference. With this greater angle it was possible to get a true involute tooth. Mr. Smith asked the author for his reasons for selecting a formed grinding wheel rather than a straight-faced wheel for his process. He also asked what precautions were taken to keep the grinding wheel true.

Mr. Orcutt, in replying to the discussion, said that indexing had probably given more trouble than any other development of the gear grinding machine. The form of the wheel was fairly well mastered, although fresh improvements were being made every day. Mounting was very important, but he did not think it could be properly studied until gears themselves were more accurate. An illustration was to be found in the electric traction work. The gear was mounted on one end of an armature shaft, and did not stay in line five minutes, although it was fairly parallel at first. He thought that before the traction problem was really satisfactorily solved with reduction gears, there must be a very rigid bearing to keep parallelism between the teeth. When that was done, other things would follow. It must be remembered that in that class of work shock was the great thing to deal with, and there must be weight and suitability to deal with the terrible shocks in railway working. As to helical gear, which Mr. Newton had mentioned, it might be possible to grind it, but he would like to have it understood that helical gear would not be displaced in any way; it had to be more accurate before it would stand what the best spur gear would stand when it was accurately ground. Answering Mr. Wright, Mr. Orcutt said he did not see how with perfect theoretical continuous contact there could be any impact. Elasticity certainly came into the troubles. In most cases the noise in gears was due to the springing of the gear tooth itself. The only explanation seemed to be vibration. With reference to the $^{3}/_{1000}$in., that was the total error. Mr. Hunt had spoken of soft ground gears. Mr. Orcutt thought there was a great field for soft gears, especially in some cases where accuracy of indexing was required, such as printing gears and loom work. Use could be made of the highly accurate gear which could only be made by grinding, and in other things, too, there were cases where soft gears were used at very high speeds transmitting no load. In soft gears there was going to be a wide field when grinding was appreciated and made use of. Tram gears were hopeless. The diameter of gears that could be ground was of very great interest. The diameter was not very great at present, but there was no reason why very large gears should not be ground. There was no difficulty in hardening gears 3ft. diameter. It had taken a good deal of study before that had been mastered, but it had been mastered in motor car gears. Mr. Heathcote had spoken of the modified involute tooth. So far, he (Mr. Orcutt) had found that the true involute was best, and the one which gave the best results.

THE large consumption of graphité for the manufacture of crucibles seems, according to a report of the American Bureau of Mines, to be threatened by the decreasing demand for crucibles through the increasing use of electric furnaces. The percentages of consumption in the various industries in recent years have been estimated as follows:—Crucibles, 45 per cent.; lubricants, 10 per cent.; pencils and paints, 5 per cent.; foundry facing and stove polish, 30 per cent.; other uses, 10 per cent.

Proposed New Line for the Metropolitan Railway.

AT the present moment the Metropolitan Railway is seriously handicapped in the handling of its heavy residential traffic by the tunnel section of line that extends from Finchley-road to Baker-street. Over that section approximately 800 trains have to pass daily, and, with the limitation it imposes, increasing difficulty is experienced by the company in giving an adequate service to the inner suburban areas. To obviate the difficulty, the railway company is seeking parliamentary powers to construct a relief line which it is expected will materially facilitate the manipulation of the traffic and enable an increase to be made in the train service.

It is proposed, as will be seen from the accompanying map, that the line shall run parallel, on a falling gradient, with the existing Metropolitan line, from a point immediately south of Willesden Green Station as far as Mapesbury-road, which is situated a short distance north of the company's Kilburn and Brondesbury Station, making a triplicate "up" and "down" line over this portion of the railway. The new line will then change direction and burrow under the Metropolitan fast and local lines, entering two deep-level tunnels, which will pass under High-road, Kilburn, Maida Vale, and Edgware-road, and make junction with the Metropolitan Inner Circle lines by means of a 200-yard "cut and cover" section a few yards west of Edgware-road Station.

It is intended, by adopting the "tube" method of construction to cause the minimum amount of disturbance to the property and streets above. The tube tunnels, which will be constructed of cast iron segments, will be of the exceptional diameter of 15ft. 6in., in order that the company's main line rolling stock and electric locomotives may operate through them, whilst the distances between the tunnel rail level and the street level will vary from 25ft. 6in. to 75ft. 9in.

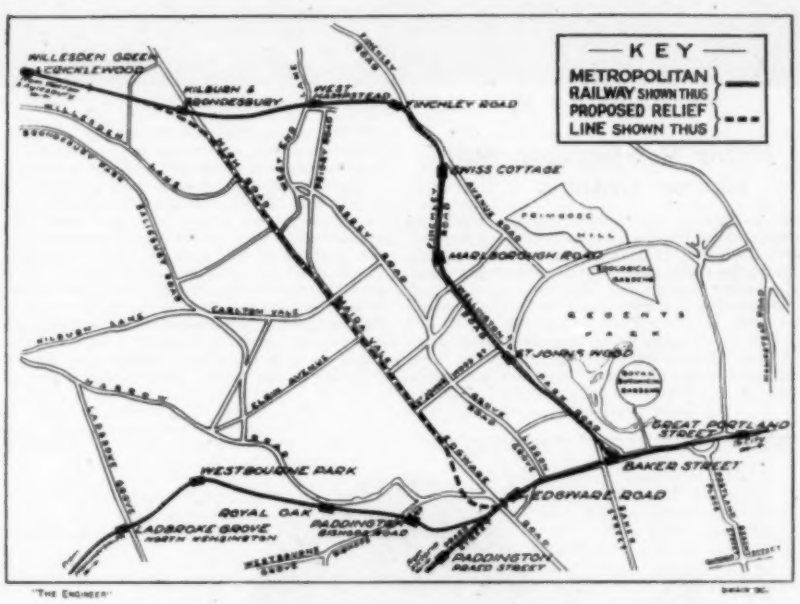
By resorting to the construction of an entirely new line instead of doubling the existing railway, the company will tap a new and important area. The line will run through the administrative areas of four authorities—the urban district of Willesden, the boroughs of Hampstead, Paddington and Marylebone—and will have three stations conveniently placed along the route.

It is calculated that the work of construction could be completed within a period of two years from the date of the commencement of operations. If, as is anticipated, having regard to the many public advantages afforded by the new railway, there is no serious opposition to the Bill, and if the measure passes quickly through all its stages, the contracts for the work will be placed without delay.

Coinciding with this new relief line scheme, very extensive alterations are being made at Edgware-road Station, in order to enhance its usefulness and effectiveness. The track lay-out is being entirely altered, the station structure demolished, and an enlarged and remodelled building erected, whilst four platforms, each capable of accommodating eight-car trains, are being provided, instead of two short platforms as at present. The effect of these improvements will be that trains from the new line will be handled with ease and that an increased train service will be made possible.

Another scheme that will interlink with the proposed relief line is the work of doubling the most important section of the Inner Circle lines, which is now well in hand. It consists of electrifying and utilising the present steam lines which run parallel with the Metropolitan Circle lines from King's Cross to Moorgate, which has been accomplished by the construction of a length of tunnel between Euston-square and King's Cross. This scheme, which it is expected will be finished in January next, will provide an alternative route to Moorgate, and give the travelling public a maximum service of trains.

The company is re-arranging the signalling sections on its lines between Wembley Park and Harrow, by introducing additional train sections, and installing some of the latest three-aspect colour light signals, in addition to providing fog repeater signals. The completion of the new work on this important section will lessen the intervals between trains, and enable a more speedy service to be given, which, it is anticipated, will bring a measure of relief to the whole of the service before the new line to Edgware road can be put into operation.



MAP SHOWING ROUTE OF PROPOSED NEW METROPOLITAN LINE

ACETYLENE WELDING AND CUTTING.

AN ordinary meeting of the British Acetylene and Welding Association was held at the Old Colony Club, Aldwych, on Wednesday, the 9th inst., and was preceded by a dinner, presided over by Mr. Henry E. Baker, the new honorary president. Some brief speeches were made at the dinner, including one by Colonel Cooper Keyes, but the chief business of the evening was to hear a lecture by Mr. C. S. Milne—British Oxygen Company—on the present position of oxy-acetylene welding and cutting. It was a long discourse, occupying over two hours in its delivery, so it will be readily appreciated that a large amount of information was available. One of the most interesting parts of the paper was that dealing with the cutting of cast iron, which, the author said, could be readily done without any extraneous assistance, such as the use of special fluxes, if the proper kind of blow-pipe were used. In this connection he showed a number of lantern slides, including one of some 42in. cast iron pipes, cut out in Oxford-street, which were a hundred years old, and the first of their kind laid in London. Another interesting part of the lecture dealt with the system of oxy-acetylene lead-burning, recently developed by Allen-Liversidge, which was demonstrated at the Shipping and Engineering Exhibition. Mr. Milnes' remarks on the relative merits of the alternative methods of making acetylene by adding water to carbide, and adding carbide to water, left the impression that neither method is entirely satisfactory, and that the whole process requires investigation *de novo*.

NEW B.E.S.A. ELECTRICAL STANDARDS.

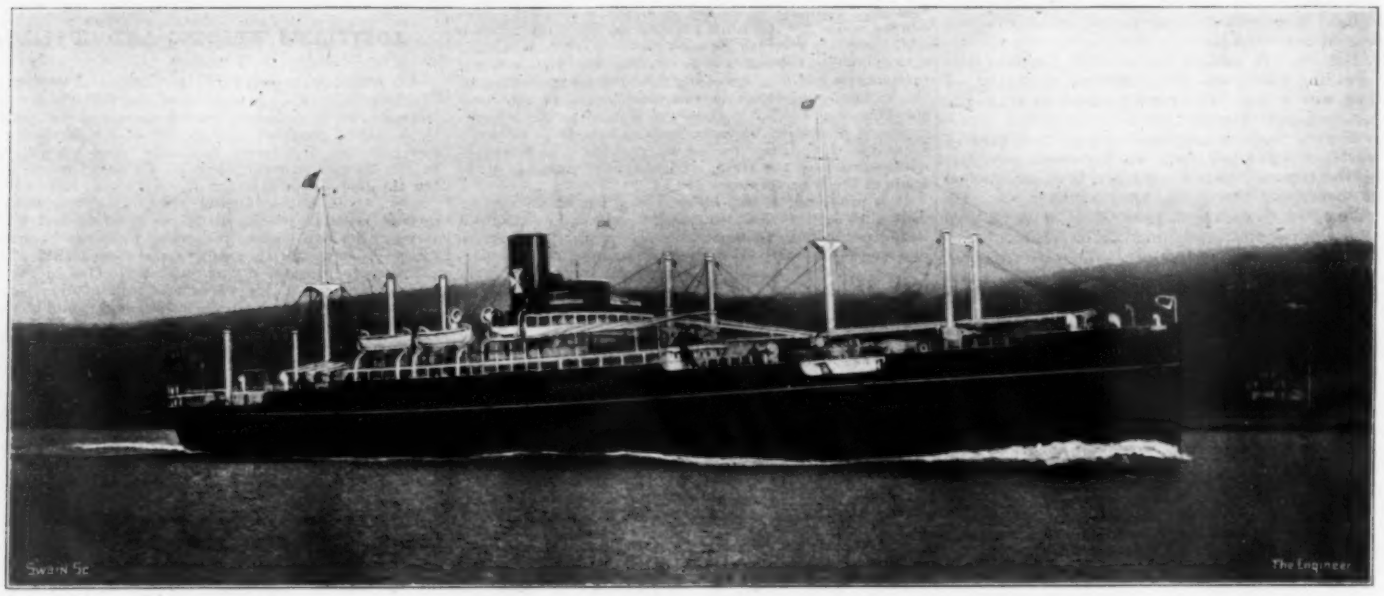
THE revision of B.E.S.A. publication No. 72, 1917, "Standardisation Rules for Electrical Machinery," is now nearing completion. Early in the deliberations of the Committee which has undertaken the revision, it was decided to divide this revision into eight different parts, each part to be issued as a separate specification. Two parts have already been issued, namely, No. 168, "Electrical Performance of Industrial Electric Motors and Generators with Class A Insulation," published in February, 1923, and No. 173, "Electrical Performance of Traction Motors (Direct-current Series-wound)," published in December, 1923. The B.E.S.A. now announces publication of three further parts, as follows:—B.S.S. No. 169, 1925, "Electrical Performace of Large Electric Generators and Motors (Load with Overload Rating)"; B.S.S. No. 225, 1925, "Electrical Performance of Alternators of the Steam Turbine Driven Type"; B.S.S. No. 226, 1925, "Electrical Performance of Large Electric Generators and Motors (Continuous Maximum Rating)."

The temperature rises included in these three specifications were agreed at a meeting of the International Electrotechnical Commission, held at The Hague last April. It is hoped to complete the three remaining parts of the revised publication—*i.e.*, Transformers, Rotary Converters, and Fractional Horse-power Motors—early in the New Year. Copies of these three publications may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. each post free.

A NEW directional wireless station, working continuously throughout the twenty-four hours, has been installed at Belle Isle at the northern entrance to the Gulf of St. Lawrence. The new station uses a wave length of 800 m. with the call sign VCM. It should prove of special value to vessels on the Northern Transatlantic route.

THE HOULDER LINE MOTOR REFRIGERATOR SHIP UPWEY GRANGE

THE FAIRFIELD SHIPBUILDING AND ENGINEERING CO., LTD., GOVAN, BUILDERS AND ENGINEERS



The Motor Refrigerator Ship Upwey Grange.

THE motor refrigerator ship Upwey Grange, which was recently completed for the Houlder Line, Ltd., of London, by the Fairfield Shipbuilding and Engineering Company, of Govan, bears the distinction of being the largest meat-carrying refrigerator ship afloat. The trade in which this vessel will be principally engaged will be that of carrying chilled meat from the River Plate to ports in the United Kingdom. The photograph which we reproduce above shows the Upwey Grange on the Clyde, the view being taken at the time of her successful measured mile trials. The following are the leading particulars of the hull and machinery :—

Hull Particulars.

Length overall	451ft.
Breadth moulded	62ft. 3in.
Depth moulded to shelter deck	38ft. 3in.
Draught	24ft. 8in.
Gross tonnage	9130

Refrigerated Space.

Refrigerated capacity of holds	564,000 c. ft.
Number of chambers	32
Refrigerated ship's stores	3000 c. ft.

Main Propelling Machinery.

Type :	Twin-screw, Fairfield-Sulzer, two-stroke, single-acting motors
Number of cylinders per shaft	6
Diameter of cylinders	28in.
Piston stroke	39in.
Total output	6400 B.H.P.
Normal running speed	117 revolutions

The vessel is of the shelter deck type, with a long bridge and forecastle, and she is built to Lloyd's highest 100 A 1 + class. As will be seen from the illustration, she is rigged as a fore-and-aft schooner, and her two masts are telescopic in order that the ship may sail on the Manchester Ship Canal. The hull is divided into four compartments forward of the machinery space and three aft, there being seven cargo hatchways varying in length up to 37ft. 6in.

A feature of the deck machinery equipment is the arrangement made for the rapid handling of cargo. There are in all twenty-four winches and derricks, each capable of handling weights from 6 to 12¼ tons, whilst the large 12¼-ton derricks are designed for working in pairs, so that a maximum weight of 25 tons can be put aboard with the ship's own lifting gear. Where the derricks are not attached to the masts, large derrick posts are provided which also act as ventilators. The lifting appliances are so arranged that cargo can be shipped or discharged over both sides of the ship simultaneously.

Accommodation.—Quarters for the crew and petty officers are provided on the shelter deck amidships, whilst the officers' and engineers' cabins are arranged on the bridge on the boat decks. The captain's accommodation is on the captain's bridge, and there is a limited number of passenger cabins on the bridge deck-house forward. The state rooms are single-berth cabins, and a large dining-room and smoking-room are provided, along with a verandah café. The galley, which is placed aft of the dining-room on the bridge deck, is fitted with the latest kitchen appliances, both the cooking range and the ovens being arranged to burn oil fuel. The ship's stores are so placed that direct access from the galley to the stores is given. On the after deck a fully equipped hospital and dispensary are provided, as the vessel is replete with all medical and sanitary requirements in order to comply with the regulations of the Uruguayan and the Argentine authorities. The safety equipment complies with the latest Board of Trade rules for safety at sea, four lifeboats, operated by Maclachlan patent davits, being fitted.

REFRIGERATING EQUIPMENT.

The refrigerating equipment of the Upwey Grange is specially interesting because it is designed to supply one of the largest and most elaborately subdivided cargo holds yet constructed. Some particulars of the refrigerated cargo and ship's stores spaces are given in the above table. In addition to the thirty-two chambers, there are twenty-two hatch trunkways, which in themselves form small cargo chambers. Apart from the refrigerated space, two 'tween deck spaces are arranged for the reception of general cargo.

There are two refrigerating machines, supplied by J. and E. Hall, Ltd., of Dartford. They are No. 15A H.A.S.T. horizontal machines driven each by its own condensing steam engine The CO_2 condensers are provided with copper coils, and are contained in a cast iron casing, whilst the CO_2 coolers have coils of solid drawn steel tube and are enclosed in a steel casing. Each of the two units is designed to maintain the required temperatures throughout the ship with a full cargo, without the necessity of running continuously. On the other hand, when both machines are running, the cargo can be dealt with remarkably quickly. In short, provision has been made to meet every possible contingency.

The insulated spaces are all lined with granulated cork, which is, in turn, covered by a wood lining. Messrs. J. and E. Hall also supplied the necessary pipework and meat-rail equipment. The brine circuits are of very moderate length, and are so arranged to give an efficient distribution of the cooling effect, whilst provision is made to avoid stoppage which might be caused by the temporary blocking of one section.

There is a centralised temperature control station, the system employed being Hall's three temperature open-

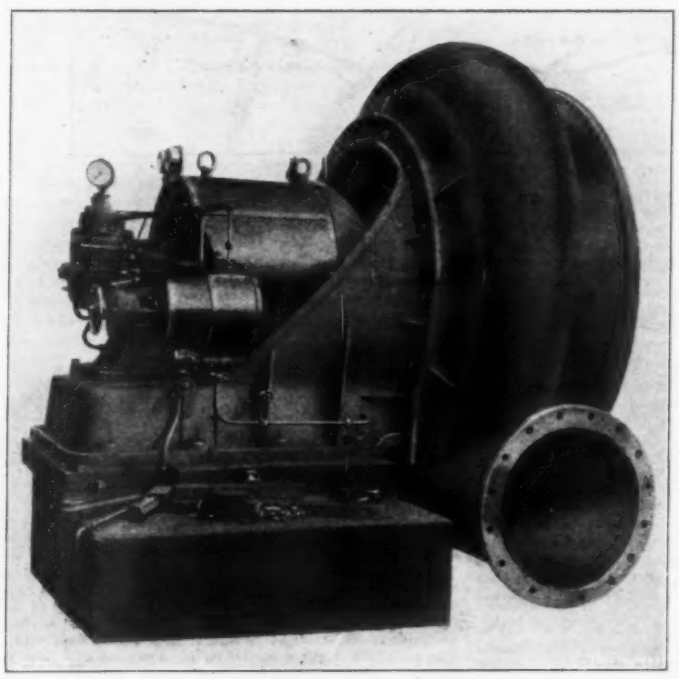


FIG. 1—STEAM TURBINE-DRIVEN SCAVENGING BLOWER

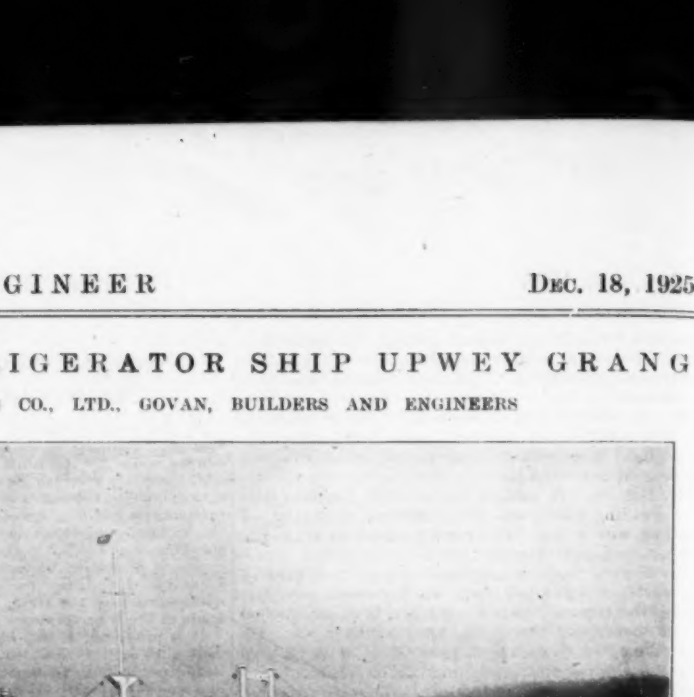


FIG. 2—BLOWER CHARACTERISTICS

return system. Other auxiliary machinery in the refrigerating compartment comprises four duplex steam-driven brine pumps by A. G. Mumford and Co., Ltd., Colchester, and two large water pumps with bronze water ends. The design and erection of the installation was carried out in close collaboration with the consulting engineers, W. Esplen Son and Swainston, Ltd., of London.

MAIN PROPELLING AND AUXILIARY MACHINERY.

The main propelling machinery of the Upwey Grange consists of a twin-screw arrangement of Fairfield-Sulzer two-stroke cycle single-acting engines, which is designed for a total output of 64,000 brake horse-power at a normal speed of 117 revolutions per minute. In general, the engines are similar in design to the four sets of machinery which were installed in the quadruple-screw passenger liner Aorangi. This machinery was described at some length in THE ENGINEER of January 2nd and the three following issues. The engines have the same stroke as those of the Aorangi, namely, 39in., but the cylinder bore is increased from 27¼in. to 28in., so that each unit is capable of developing 3200 brake horse-power at a normal speed of 117 revolutions, the mean effective pressure being about 70 lb. per square inch. The main control station is at the after end of the top platform, from which easy access is given to the two scavenging blowers, arranged in the wing compartments, to the workshop, stores and the electric lighting plant. The 100-volt, 25-kilowatt G.E.C. dynamo sets are driven by Ashworth and Parker twin-cylinder steam engines, designed to run at a speed of 260 revolutions per minute.

An interesting device which, we believe, is fitted for the first time to a motor ship is an apparatus for extracting the oil vapour from the main engine crank chambers, and preventing that faint blue haze of lubricating oil mist which has been met with in some marine oil engine installations, and has been considered detrimental to the health of the engine-room staff. The apparatus is fitted above the engines on each side of the ship, and each set comprises a cooler and fan with a vent pipe connected to the middle of the crank chamber. The air from this chamber is drawn off by the fan and any oil held in suspension is condensed or deposited in the cooler, and is drained off at intervals.

Air from the engine-room is drawn into the crank chamber from vents situated at either end of the engine framing, and the circulation of cool air tends to keep down the temperature of the running parts. An appreciable amount of lubricating oil is recovered by the apparatus. The device was designed by the Fairfield Company, in conjunction with Serck Radiators, Ltd., which company also supplied the oil coolers used in connection with the main engines.

The supercharging and scavenging blowers on the Upwey Grange were built by the British Thomson-Houston Company, Ltd., of Rugby, and each blower has a capacity of 33,600 cubic feet of free air per minute at 14.70 lb. per square inch absolute, and 60 deg. Fah., delivered at a pressure of 1.80 lb. per square inch gauge. Also each set is capable of delivering the same quantity of air at a pressure of 2.10 lb. per square inch gauge. Furthermore, the blower can deliver 36,500 cubic feet of free air per minute at 14.70 lb. per square inch absolute and 105 deg. Fah., against a delivery pressure of 2.10 lb. per square inch gauge. Curves which show some of the characteristics of the two blowers are reproduced in Fig. 2.

The blower is of the single-stage design and is driven by a three-stage turbine, having velocity compounded stages of the Curtis type, the general appearance of the unit being shown in Fig. B. It will be noted that the scroll casing of the blower is carried on a massive bracket, which also forms the supporting base for the turbine. The blower is provided with movable discharge vanes of the British Thomson-Houston Company's improved design. These vanes permit, so the makers inform us, a very much wider range of operation without pulsation than has been offered hitherto in this class of machinery, and at the same time they are very easily manipulated from outside the casing of the blower, while the design permits of their being placed in the best position for the efficient operation of the propelling machinery.

The oil supply for the main engines is used to lubricate the bearings of the blower by gravity, and it is also employed to operate the air pressure control through a servo-motor which adjusts the steam supply throttle valve on the turbine. The delivery air pressure from the blower acts on a spring-loaded piston, controlling the movement of a pilot valve supplying oil to the servo-motor, which is directly connected to the turbine steam supply throttle valve. It is possible to vary the air pressure at will from the starting platform of the main propelling engines by means of a very simple device interconnected with the air pressure governor. As the turbine is provided with hand-operated valves which can be opened and closed at will to cut in or cut out groups of steam nozzles in the first stage of the turbine, the most economical conditions of running may be maintained according to the duty with which the scavenging blower is dealing.

Other engine-room machinery includes two three-stage air compressors of the Weir type and two 70-ton oil pumps for piston cooling. For the main crossheads, three 2-ton high-pressure crosshead lubricating pumps are supplied, and three forced lubrication pumps for supplying oil to the main bearings, also two oil transfer pumps. These pumps are of the Weir type and are steam driven. Cooling water for the engine jackets is furnished by two Drysdale pumps driven by steam engines. Dawson and Downie, Ltd., of Clydebank, supplied the bilge, ballast, sanitary, fresh water and general service pumps.

Steam for the engine-room and deck auxiliaries is supplied by two single-ended oil fuel boilers, designed for a working pressure of 180 lb. per square inch. The boilers are fitted with Tompkin's patented tangential steam dryers. The boiler auxiliaries include feed pumps, a monotype air pump for the condenser and a 30-ton evaporator, all of Weir type and a Carruthers hot-well tank and gravitation filter for the feed water supply.

During the trials on the Clyde a mean speed of 16.29 knots was obtained with the vessel light and trimmed down 10ft. by the stern, which was an exceptionally good performance. The engines developed 6600 brake horse-power, corresponding to a speed of 121 revolutions per minute. The Upwey Grange left London on November 18th, and after a very successful voyage has now arrived in the River Plate.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Position.

BUSINESS in the Midland iron and steel industries remains quiet, and little of moment has occurred during the week. Attention is paid chiefly to the steel department, where the slump in values appears to have been arrested owing to the withdrawal by large firms of the very low rates they were prepared to accept a fortnight ago. The iron and steel trade has now fully entered upon the period of inactivity which ordinarily occurs at this season. Present indications suggest that the intermission will be longer than usual. Local works are working off their material ready for stocktaking, and are buying only just sufficient to carry them over the Christmas holidays.

The Steel Situation.

The improvement in steel prices is maintained, and though competition for all the available business is exceedingly keen, the very low quotations of a fortnight ago are not resorted to. This slight stiffening of structural material values may not be really significant, but it is causing consumers some anxiety as to the future trend of events. The uncertainty, moreover, is proving an obstacle to enterprise. So far as contractors are concerned they would be glad to see prices stabilised, even though it involved paying more. They have no mind to incur heavy risks in order to accelerate projects which look tempting to their originators at current prices. It is fairly evident that although there may be nothing in the much talked of price agreements as a future policy, the tactics of price cutting which have brought prices to an uneconomic level have been modified. It is assumed that firms are already doubting the wisdom of selling their output at a loss. The market is not unprepared for a determined effort to lift steel prices above the profitless levels to which they have receded. Quotations for angles and joists this week were higher, makers generally asking £7 5s. as a minimum. Buyers were not disposed to give way, and it would be premature to say how the fight will finish. Makers of small steel bars have met with some little success in their endeavours to improve upon recent selling prices, but they are not proof against the temptation to shade their £8 quotation. The position is irregular, for though firms well placed are asking rather higher figures, others are still prepared to shade their prices. Continental competition is keen. At the beginning of the month foreign ship-plates were quoted £5 19s. f.o.b. Antwerp, and this figure has since been reduced to £5 17s. 6d., ordinary plates being 2s. cheaper at £5 10s. Continental reports state that the French mills are filled up to the end of February, but there appears to be great anxiety for British business. Large quantities of foreign sheet bars are being used for black and galvanised sheets obtainable at £1 cheaper than the native price. Home billets, which are quoted £6 2s., against £5 5s. for foreign, are slow of sale. Steel scrap continues firm at £3 7s. 6d. delivered South Wales. Business in all departments is patchy, but constructional engineers' requirements make a fair aggregate.

Raw Iron.

Pig iron demand has fallen off to some extent, but it shows improvement on a couple of months ago. Both buyers and sellers are proceeding with caution, the firmer tone of the coke business having an influence on the former. That smelters consider it only a temporary lapse due to the end of the year quietude, and that they are anticipating good business in the New Year is shown by the fact that more blast-furnaces are being held ready to go into commission, and two or three are being re-started in the North. There has been no call for larger production so far as this district is concerned, however. In this connection it is good to recall there were 141 furnaces in blast at the end of the month, a net increase of five furnaces compared with the number in blast at the beginning of the month, six having been put into blast and one blown out. The steadiness of the trade in foundry iron still depends mainly on the district demand for light castings. Though present market conditions are too flat to afford a medium for bracing up prices, furnacemen are offering a firmer front to deteriorating tendencies. Northamptonshire No. 3 foundry is quoted at £3 2s. to £3 2s. 6d., and Derbyshire at £3 5s. to £3 6s. at furnaces. There is little inquiry for forge numbers. Most smelters decline to make contracts at present rates beyond March. Hematite has firmed up and has become somewhat scarce. Pig iron production is slightly more costly than it was, owing to the rise in the value of furnace coke, and it is stated that present selling prices barely cover the cost of production.

Finished Iron.

From the state of affairs at the mills and the fact that the reduction in values of best bars has not had the desired result of stimulating demand, it would appear that the South Staffordshire finished iron industry has not shared with raw iron and steel the improvement in business which has been in evidence since the market tone picked up in October. The local mills are only poorly employed, work being less regular than ever, and manufacturers cannot look far ahead. Best grade bars have lost their relatively favourable position, being now £14, against £15 in January. The state of suspended animation to which engineering in the coal mines has been brought has reacted seriously on the demand for best bars. The market for Crown bars is dull, and competition is such that producers in this area have little chance of securing orders against Northern or foreign firms. The official bases for Staffordshire Crown and common bars remain nominally £12 and £11, though, as has been previously pointed out, these figures have not been adhered to for some time owing to the price readjustments made in relation to similar classes of iron by the Lancashire producers. Much less Belgian iron is coming into the district, as the result of the continuance of the strike in Charleroi, and this has, doubtless, diverted some business to Staffordshire mills. But local iron for nut and bolt making costs so much more than foreign that nut and bolt makers, no doubt reluctantly, are changing over to steel to an increasing extent. This metal can be bought about £3 less per ton than iron. Considerable introduction of special machinery has been found necessary for the change, but the works are better equipped for meeting the formidable foreign competition as the result. It is understood that iron would be preferred, the contention of the ironmasters being that the greater corrodability of steel must shorten the life of bridges and other structures in which fastenings of this material are employed. Black Country tube works are taking good quantities of iron strip, certain firms preferring iron, although this costs £12 per ton, as against £8 for steel strip.

Galvanised Sheets.

The galvanised sheet trade continues busy, with bookings up to March for corrugated sheets of 24-gauge at £16 12s. 6d. to £16 15s. Some of the larger markets are not buying as heavily as they were, but unusually good business is being done with Mediterranean ports.

Production Figures.

The production of iron and steel in November is considered by Midland industrialists to have been fairly satisfactory. In each case there was an advance on the preceding month, but the quantities are slightly below those of November last year. The production of pig iron amounted to 494,100 tons, compared with 473,700 tons in October, and 583,500 tons in November last year. The production included 153,000 tons of hematite, 171,500 tons of basic, 124,400 tons of foundry, and 20,000 tons of forge pig iron. The production of steel ingots and castings amounted to 653,800 tons, compared with 652,400 tons in October, and 674,300 tons in November, 1924.

Death of Mr. J. W. Hunt.

I much regret to have to record the passing of Mr. John William Hunt, the founder of the Chillington Tool Company, Ltd., Wolverhampton, who died on the 10th inst., at his home, Maycroft, Ash Hill, Compton, in his eighty-second year. Mr. Hunt founded the Chillington Tool Company, Ltd., in 1892, and was chairman of directors from that time until his retirement from business three years ago. Under his direction the works grew steadily, until at the time he relinquished control it found employment for nearly 1000 people. He was held in high esteem in Midland industrial circles.

Derbyshire Colliery to be Closed.

The Staveley Coal and Iron Company, Derbyshire, has given notice that owing to bad trade its Dowell Colliery will be closed for an indefinite period.

Unemployment.

The latest unemployment returns for the Midlands show an increase of 1679 on the week. The total of 122,606 is not only an increase on the previous week but also on the week before, when the figure stood at 122,103. In the Birmingham area the latest return shows about 700 more persons as being unemployed. Bilston shows an increase of 400 and the Stoke-on-Trent area of about 200. Of the total 92,361 are men, 1449 boys, 26,475 women, 2321 girls. There are now out of employment in the Birmingham area, 21,714; at Coventry, 1468; Bilston, 2536; Cradley Heath, 3790; Derby, 2453; Dudley, 3269; Leamington and Warwick, 437; Leicester, 3113; Northampton, 1550; Nottingham, 6847; Oldbury, 1174; Peterborough, 346; Redditch, 1196; Smethwick, 2758; Stoke-on-Trent area, 14,366; Stourbridge and Brierley Hill, 3101; Tipton, 1610; Walsall, 4222; Wednesbury, 2423; West Bromwich, 2367; Wolverhampton, 4143; Worcester, 1700.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

ALL the markets this week are dull and quiet, although the prices do not show much change. Buyers seem inclined now to postpone all operations until the New Year, and appear rather indifferent to the suggestions of sellers that the markets will not be so easy after the turn of the year as they are at the present moment. The Vickers report had rather a depressing effect, although it is, of course, well known that the actual capital value of a great many big concerns has been very largely reduced during the past year, and there can be no reason why the facts should not be faced. In truth, it is better to know the worst and not to be troubled with vague apprehensions. There seems to be a good deal of nervousness in commercial circles as to the coal position, and a fear that nothing effective is being done to meet the crisis which will occur when the subsidy period comes to an end. Apprehension of this kind may be a disturbing factor all through the spring; and in that case it is very difficult to see how any revival of trade can take place. Lancashire is, of course, hopeful that a great expansion may occur in the cotton industry as a result of the supply of cheap and plentiful raw material; and if this hope be realised some improvement in engineering and foundry work might result.

Metals.

The setback in the copper market seems to be more permanent than was at first anticipated. After ignoring the fall in standard copper for about a fortnight, the manufacturing trade has so far recognised it as to reduce the price of copper sheets by £2 and of copper tubes by ¼d. per lb. In the copper market it is still maintained that the consumption in the United States is quite good,

and that the present weakness is entirely caused by the failure of the European market, and especially of Germany. The latter is always attributed to lack of capital, and steps are now being taken to remedy the trouble. It is too early yet to say whether there is a good chance of success; but if the buying power of Germany can be restored, copper prices would in all probability recover sharply. In the local market the recent fall in copper prices seems to have destroyed the confidence which was growing up. Consumers are again averse from holding more stock than is needed for immediate use; and merchants are nervous about using their persuasive powers when trying to sell. Hence business is restricted, but in any case it could not be very brisk with the holidays so near at hand. Dealers in old metals have reduced their buying prices, and in Manchester they are now paying only £56 per ton for clean collected copper, and £46 for ordinary mixed gunmetal scrap. In the market for tin sentiment here is still fairly strong, and there are a good many people who expect to see £300 per ton. The movements in price are still very frequent, but they do not set in one direction, and what is gained one day is lost the next. It is believed here that America will very soon be compelled to buy considerable quantities, and that if this occurs when the market for standard is over £280, the price might easily be lifted to £300. Lead has been rather a dull market, and is still inclined to ease; but the question is whether the effect of large arrivals from Australia has not now been discounted. Spelter remains a fairly steady market, without any special feature.

Pig Iron.

There is a small local demand for foundry iron this week, but it is gradually declining as the holidays approach, and but little business is expected here after the present week, until the middle of January. There has been some easing off in the prices quoted, although as a rule Derbyshire No. 3 is not offered here at less than 93s. One or two orders may be taken at 92s. 6d. per ton delivered in Manchester, and some Lincolnshire No. 3 can be bought at 71s. 6d. to 72s. Makers of pig iron maintain that the prices will advance again after the turn of the year, because it is generally expected that Midland coke will be dearer; but, of course, a rise in pig iron does not necessarily follow a rise in coke, and unless trade is better makers may be compelled to pay the extra cost themselves. There is, however, some disposition on the part of the large consumers to enter into contracts for delivery over the whole of 1926, but only at the lowest prices of the day, whereas sellers claim that if yearly contracts are to be taken at all the price must be consideraby more than the prompt figures. Some forward business in foundry iron over the first four months of the year has been done, but so far negotiations for yearly contracts have failed. The mere fact, however, that consumers have been willing to enter into far-forward engagements is an indication that present prices are thought to be safe; and, indeed, any further reduction of pig iron prices would probably lead to blowing-out of more furnaces. There has been more inquiry for Scotch iron from the textile machinery makers, and the prospects for this class of engineering are better now than they have been for a long time. With plenty of cheap cotton Lancashire is bound to become more active, and new machinery is urgently wanted.

Finished Material.

There is very little news in the markets for manufactured iron and steel. The recent reduction in "marked bar iron" has no effect here. The demand for Crown bars is assisted to a small extent by the delays in the arrival of foreign iron; but, of course, the prices locally are far too dear. The finished steel prices are not too regular, and buyers seem able to do much as they choose. There is, however, an attempt to prevent further cutting, and the price of steel plates here is supposed to be fixed at £7 17s. 6d. They had been sold at £7 10s., and, of course, foreign plates at the Manchester docks can be bought at fully £1 per ton less than the lower price.

Scrap.

The market for scrap shows very little movement at the moment. Dealers here are still paying 52s. 6d. per ton on trucks for heavy steel melting scrap, and there is a small demand in Sheffield at 62s. 6d. delivered. For heavy wrought scrap 67s. 6d. at the forges is still paid, but some dealers are now trying for 70s. The demand for cast scrap remains rather poor, and dealers find that it is not now easy to get 72s. 6d. per ton, even for good broken machinery iron, unless it comes from textile machinery. For ordinary qualities of cast scrap 70s. seems now to be a full price.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron trade in the North-West district continues to develop slowly, and it is possible that in the New Year more furnaces may be put in. The Carnforth Ironworks, it is said, are contemplating putting one in shortly. The trade is mostly developing in connection with Scotland and the Midlands, which two districts are taking more iron and the inquiries, although by no means exceptional, are assuring. There is a bigger tendency to order for forward deliveries. There could not be a better sign than this. The continental business in ordinary mixed Bessemer numbers is nothing to speak of, and the fall of the French franc has not tended to encourage business. American business is spasmodic, but further shipments are more than likely. Inquiries for special qualities are coming from both America and the Continent, and this branch of the iron trade is likely to improve considerably.

Iron Ore.

There is a distinct improvement in the native ore trade, and quite apart from the increased demand locally there are orders coming from smelters in Scotland and elsewhere. The restarting of the Hodbarrow mines was evidence of this. Foreign ore is in better demand, and more frequent arrivals from Spain and Norway may be expected now.

Steel.

The steel trade is livelier, and there are more inquiries about. Workington rail mills are moderately placed for business, and have orders that keep them engaged three weeks out of the four. As far as Barrow is concerned, fresh orders are required for rails to keep the mills going, and there are hopes that it will be possible to secure contracts that will start the mills after they have been closed for the holidays.

SHEFFIELD.

(From our own Correspondent.)

End of the Year Slackness.

STOCKTAKING and the approach of the holidays have combined to give the heavy steel trades a quiet appearance, and there will be little done now until the end of the year. Interest is centred on New Year developments, which, it is generally believed, will be of a cheerful character. Feelings of confidence are pretty widely expressed, and though no one is inclined to indulge in any sort of speculation, it is significant that steel makers have arranged for the delivery of a good deal of material early in January. To a certain extent the scrap market is sharing in this, but the number and size of transactions are insufficient to have any real influence on the market. There is no alteration in the number of steel furnaces in commission, and acid steel is selling better than basic. A fair amount of steel is on order for delivery early in the New Year, and it is hoped that there will not be much delay in the placing of a good deal of business that is known to be pending. Following the reduced prices for rolled mild steel there has been an increase of business. It does not appear as though the Government intends to grant the appeal of the steel makers for assistance under the scheme for the safeguarding of industries. The application is supported by producers of raw and partly finished steel of the lower qualities, who are suffering from foreign competition of a severe character. Although it might be possible to bring their prices a little lower, though that is very doubtful, there is certainly no chance of them quoting prices anywhere near those of the French or Belgians. Strong opposition has come from the re-rollers, who state that a large proportion of their work is exported, and that this trade would be ruined if they were forced to get their raw material at the higher British prices.

Engineering Departments.

Heavy engineering is not making very much headway, and several important Sheffield firms are finding it an almost impossible task to make good in other directions the shortage of work from shipbuilding centres. Marine castings, forgings and plates are only in restricted request, and armament work, of course, is still in the depressed state which has prevailed for so long. Railway work, too, is running short, and contracts for springs, axles, and tires, which are nearing completion, are not being replaced at as quick a rate as could be desired. About forty men employed at the Doncaster railway plant works have received a week's notice. This decision affects machine hands and fitters who were the last comers. Extra men were taken on for the building of "Pacific" engines, an order for twenty of which was completed recently. In certain sections of the machine shops double shifts have been worked for the last two years, and it is understood that one shift is to be abolished. The men affected were working two at a machine in most cases. In a statement, the assistant mechanical engineer, South area, London and North-Eastern Railway, said that they had more men than were required, and the night shift was being abolished. It was hoped that more men would not be dismissed. About 4000 men are now employed at the works at Doncaster.

Lighter Steel Trades.

There is a quieter demand for most classes of tools, particularly files, the output of which has dropped considerably. The almost complete cessation of Russian business is largely responsible for this. Prior to the winter season setting in a great amount of trade was done in this quarter. Trade next year promises to be equally as good, judging from the number of inquiries for files and tools for delivery next spring. Agricultural implements and parts are being well ordered, for though the inland sales are on the small side, the Colonies are taking large quantities. Edge tools are another line which is doing rather better in the export section. There has been in Sheffield another joint exhibition of agricultural tools organised by the Department of Overseas Trade and the local Chamber of Commerce. The goods exhibited were those made in foreign countries, chiefly Germany, United States, France and Spain, which are selling in the Argentine, Brazil, East Africa, South America and the British West Indies. The object of the exhibition was to give Sheffield manufacturers an idea of the competition they have to meet in these markets.

Plate and Cutlery.

A wave of severe depression is passing over the silver and electro-plate trades, and it is a long time since producers experienced such a dearth of orders. Even the cheaper qualities, which have been having the best of the market for many months, are sharing fully in the depression. Until quite recently, the output of spoons and forks was on an enormous scale, but there has been a sudden slump which is difficult to account for. January is always a quiet month for these trades, and factories will close just before the Christmas holidays for a period of five or six weeks. Cutlery prospects have improved a little, but as it is reported that German goods are being more freely imported with the object of avoiding the coming tariff, it is not unlikely that the Sheffield trade will feel the influence of this for some little time. Coupled with the safeguarding duty is the proposal of the Government to make a grant in aid of cutlery research, providing a certain sum of money is found by the trade. As Master Cutler last year, Mr. W. W. Wood was largely responsible for persuading the Government to find a share of the money needed for research, and he has since been offered the chairmanship of the Cutlery Research Association. His acceptance, however, has been deferred until some definite arrangements are made for embarking upon the scheme. It is felt in Sheffield that the trade must not rest content with the cutlery tariff, for, as one leading manufacturer put it in an interview, "New methods and new ideas must be introduced if we are to meet German and American competition. We must realise that the 33⅓ per cent. safeguarding duty does not mean that wasteful and antiquated ideas will be allowed to continue. Efforts are being made to ensure that the contribution from the trade will be forthcoming from the trade itself, and it is hoped that, in their own interests and in those of the city and the trade in general, all cutlery firms will support this scheme, which must be representative of the whole trade to be successful."

Industrial Steels.

In an encouraging short space of time, Industrial Steels, Ltd., would appear to be turning the corner. A receiver was put in during April, 1924, and withdrawn in June, 1925, after the courts had approved a reconstruction scheme. The report for the period April–December, 1924, shows that trading, after providing for all expenses incidental to the reconstruction, resulted in a net profit of £8161. After deducting the net loss of £3543 for the six months ended June last, there remains a net profit for the combined periods of £4618. The report states that the loss for the first half of 1925 was attributable to a sudden fall in the market price of raw materials, necessitating writing down the stocks. At a meeting of shareholders in Sheffield, the chairman, the Right Hon. Viscount Falmouth, said that it was somewhat premature in view of the fact that the new board had only so recently been constituted, and the conditions prevailing in the industrial world, to speak with much confidence of the immediate future of the company. At the same time he struck an optimistic note regarding the efforts which were being made to extend the business of the company both at home and abroad. It is interesting to note that among the new directors is Mr. M. Webster Jenkinson.

Swiss Machinery Ordered.

A tender by Oerlikon, Ltd., for the supply of a 6000-kilowatt turbo-alternator at the price of £19,000 has been accepted by York City Council. Thirty tenders were received from the following countries, in addition to England:—Switzerland, France, Belgium and Holland. The lowest English tender was more than £24,000. It was stated that much of the material under the Oerlikon tender would be made in England, and less than £7000 would be spent in Switzerland. Opponents to the proposal submitted two amendments, that a British machine be purchased or that an effort be made to reduce the working cost so as to make the actual cost of British machinery no greater.

Colliery Topics.

Staveley Coal and Iron Company announces that there is no prospect of its Do-Well Colliery at Barrow Hill being reopened in the near future. This up-to-date colliery had been working only a few months when it was closed because the price list proved unsatisfactory. A new list was agreed to between the company and the Derbyshire Miners' Association, and it was then believed that the pit would be reopened at an early date. The directors, however, decided that the state of the coal trade did not justify this step immediately. In the expectation of the pit reopening, many miners have declined work elsewhere, and it is this fact which has brought the latest pronouncement. About Christmas it is expected that the Barnsley seam will be reached by the Newstead Colliery Company, Ltd., in the Notts. coalfield. Two shafts are being sunk at Blidworth.

From Steel to Joinery Factory.

Henry Boot and Sons, contractors, of London and Sheffield, have purchased the Ordnance Works, Sheffield, formerly the property of Messrs. J. and P. Hill, who have removed to Darley Dale, and propose to transform it into a joinery factory for the mass production of wood fittings for houses. This firm has big housing contracts at Sheffield, Birmingham, Leicester, and Bradford, and operations have to some extent been held up by lack of joinery work. By mass production methods the woodwork of 1500 to 2000 houses will be produced yearly at the new factory.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE improvement in the Cleveland pig iron trade is well maintained. Business is certainly quieter at the moment, but it is on a better scale than is usually experienced at this period of the year, and the optimistic feeling as regards the future is becoming more pronounced. A good deal of foreign competition has still to be contended with, but there are indications of a stiffening of prices of foreign manufactures. Recent arrangements of contracts have placed manufacturers in this district in a better position than for some time past, and the outlook generally is regarded as encouraging and everything points to more idle plant being restarted in the near future. There is, however, little foreign inquiry for Cleveland pig iron at the moment, the recent rise in price having severely restricted the demand. Hopes of American business are also receding, but the home situation is healthier, and although at the moment there is the usual pre-holiday lull, makers anticipate a strong renewal of inquiries afterwards. Meanwhile they are well situated, contracts on hand being more than sufficient to ensure the disposal of the output. There is consequently no weakening on the part of sellers, and home quotations are all firm as follows:—No. 1 Cleveland foundry iron, 69s. per ton; No. 3 G.M.B., 66s. 6d.; No. 4 foundry, 65s. 6d.; No. 4 forge, 65s.; and mottled and white

iron, each 64s. 6d. To these prices 6d. per ton is added for export orders.

Hematite Pig Iron.

Prompt supplies of East Coast hematite pig iron are almost unobtainable. Makers are being hurried for deliveries by clamorous customers, and in several instances boats are said to have been delayed. However, the additional output should soon speedily relieve the situation. Prices under such circumstances are naturally very firm, and 76s. per ton is the general market quotation for mixed numbers for prompt delivery, but for January delivery some makers are still asking 75s. 6d., with number No. 1 quality at 76s. per ton.

Ironmaking Materials.

There is little change in the foreign ore trade. The tone is better, and there is more inquiry, but business matures slowly. Best Rubio ore remains unchanged at 21s. 6d. per ton c.i.f. Tees. Coke is extremely scarce, and the approach of the holidays tends to accentuate the shortage. It is, in fact, extremely difficult to buy coke for prompt delivery at all, and probably a premium upon the quoted price of 21s. 6d. per ton delivered at the works would have to be paid if any buyers needed prompt supplies.

Manufactured Iron and Steel.

In the manufactured iron and steel trade there has been a slight slackening in the flow of orders, but the works are fairly well situated now, except at the plate mills, which are slack on account of the dearth of shipbuilding orders. Prices are maintained.

The Coal Trade.

The position in the Northern coal trade is very encouraging. All sections of the market continue very steady, with improving prospects for the turn of the year. There is little coal on offer for the remainder of December, and full late prices are easily commanded. The recent return of snow and other bad weather, however, is likely to affect tonnage movements, and thus, while prospects are good, there is still anxiety as to a definite tonnage movement. This feeling tends to some extent to limit early transactions, and also to check any strong tone developing. The forward position seems to be moving on favourable lines, and some producers are inclined to the belief that the opening weeks of the New Year will be characterised by a very firm tone, with a definite tendency to a higher range of prices. Others are less sanguine, as they say business is not so easy to get among foreign customers, and then only in face of keen competition. The home demands continue on a fairly large scale, and some large contracts are reported. This week the Admiralty authorities have contracted for 100,000 tons of Northumberland steam coals, to be shipped to various ports during next year. The prices are said to range from 15s. to 16s. per ton f.o.b. They have also taken 15,000 tons of foundry coke on the basis of current values. Shipment of this consignment is over 1926. It has also been announced that the Bordeaux Gas Works contract has been placed with local merchants for 10,000 tons of ordinary Durham and Wear gas coals, at 20s. 3d. to 20s. 6d. per ton c.i.f. For the most part only meagre supplies of Northumberland steam coals remain undisposed of for December, and, being fairly well supplied with tonnage, fitters' position is extremely good. Best Blyth qualities are fully 15s. 3d. for over the New Year, and 15s. 6d. is being asked direct. Tyne primes are unchanged, but are easily maintained at 14s. 6d. to 14s. 9d., and seconds at 14s. 3d. to 14s. 6d. There is a small surplus of steam smalls, and prices are steadily held at 14s. 6d. to 14s. 9d., and seconds at 14s. 3d. to 14s. 6d. Durham coals are in short supply, owing to the very full December bookings, and the position is very firm. There is considerable inquiry over the beginning of next year, but actual business matures slowly. All gas descriptions are unchanged, but are strong in tone, and prices range from 16s. to 16s. 6d. for bests, according to quality; 17s. to 17s. 6d. for Wear specials; and 15s. 3d. to 15s. 6d. for secondary makes. Bunker coals are well covered until the turn of the year, and at 15s. to 15s. 6d. for ordinary classes and 16s. to 16s. 6d. for best and superior kinds the market is fully steady. Active conditions prevail in the coke trade, but operations are restricted owing to a scarcity of stocks. There is said to be a big demand from America, but definite contracts have not been placed up to the present. Prices show a marked upward tendency.

SCOTLAND.

(From our own Correspondent.)

No Change.

THE steel and iron markets continue practically without change. This is rather unusual at this period of the year, when the approach of the Christmas and New Year holidays usually brings a rush of orders to complete before the year runs out. Up to the time of writing, however, there has been little evidence of any pressure for deliveries. Shipbuilding contracts have been a little better of late, but some time must elapse before specifications are issued. Even then it is doubtful if home makers can expect to secure much business in face of cheaper continental productions. A better feeling is said to exist in commercial circles generally, but it is difficult to recognise any reason for any degree of optimism, so far as the steel and iron trades are concerned. It is questionable whether, even if all the steel and iron materials required in the shipbuilding contracts referred to were ordered, the works concerned would benefit to any great extent. In view of continental competition, it does not appear likely that home makers would secure more than a comparatively small proportion of the business in connection with these contracts. Prices have been cut, but considerably lower quotations are necessary to ensure a large flow of orders.

Steel.

In the meantime steel plates and sectional materials of all kinds are comparatively inactive. Specifications are of a very meagre description, and plants are poorly engaged. It is not uncommon to hear of mills being stopped until sufficient tonnage accumulates to warrant a restart.

Steel Sheets.

Steel sheets are in quite a different position. The export demand for black sheets continues to grow, and quotations are hardening. Galvanised varieties, too, are well booked, and the price for 24 b.g. is firm at £18 per ton for export delivery.

Iron.

Reports from the ironworks hold little of a fresh nature. Despite the reduction to £11 5s. per ton for Crown bars, business is no better. Consumers continue to favour imported material or steel bars, owing to cheaper costs compared with home-produced iron. The prices obtainable for re-rolled steel bars are still on an almost unremunerative level, the competition for any orders coming on the market being particularly keen.

Pig Iron.

Weakness is still apparent in the tone of the pig iron market. In some cases the production is continued at a rate necessary to maintain stocks at a safety level, while, generally speaking, the total output, small as it is, easily accounts for all demands upon it. Quotations are nominally unchanged since last week.

Coal.

The coal market is firm for most sorts. Business has not developed to any extent, but exporters have been busy covering sales against shipments due to be made before the holidays. Lanarkshire splints are now fully taken up for this month, and prices are inclined to appreciate. Ells are stronger, owing to better home demands. Lanarkshire steams are about 3d. per ton dearer. Third-class Fifeshire steams are now unobtainable for shipment this month and first-class qualities are well placed. Lothians steams are not quite so favourable. All classes of washed nuts are inclined to rise in price, chiefly owing to larger home demands and to the fact that gas and electricity works are taking earlier deliveries. Household fuels are selling in large quantities in spite of the increased prices. Aggregate shipments for the week amounted to 257,092 tons, against 290,375 tons in the preceding week, and 261,374 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

IN the steam coal trade values have been well maintained, though there is not quite so much activity in business for early loading. This may be due to the fact that coals are by no means easy to obtain for shipment this month, as the collieries are very fully booked with possibly a few exceptions. Last week exports were fairly satisfactory, though slightly under those of the previous week, but this decline was not surprising, seeing that tonnage about the middle of the week fell off, though supplies improved by the end of the week. Arrivals over the week-end were fairly good, with the result that so far as Cardiff, Penarth, Barry and Newport were concerned, there were only six berths idle, whereas thirteen steamers waited to load. It is fully expected that loading pressure will be well maintained right up to the holidays. Although comparatively little fresh contracting has been done in coals for next year a certain amount of business has been arranged for shipment during the first month or so of 1926. Apart from the substantial orders reported recently for South American Railways, it is very satisfactory to find that the Egyptian State Railways have purchased 300,000 metric tons of South Wales locomotive coals instead of 200,000 tons, for which they asked tenders. Watts, Watts and Co. have secured 200,000 tons at the price of 28s. 9d. c.i.f. Alexandria, and two further lots of 50,000 tons each have been placed with W. Milburn and Co., Ltd., and T. Beynon and Co., Ltd., at 29s. 10d. and 29s. 9d. c.i.f. respectively. The tenders sent in ranged from 28s. 9d. to 32s. 4d. net c.i.f., and it would seem to be indicated that the railways considered the prices sent in by the above-mentioned firms as extremely advantageous from the buyers' point of view, since they decided to increase their quantities. Tenders have also gone in for the Great Northern Railway of Ireland's requirements of 50,000 tons over the first six months of next year, or 100,000 tons over the whole of 1926, while the Bordeaux Electricity Works are in the market for 10,000 tons to 15,000 tons of steam smalls for delivery over January, and the Swiss Federal Railways are inquiring for 30,000 tons of large coal and for 10,000 tons of patent fuel for shipment over the first three months of next year. Some other consumers abroad are asking for prices for best Admiralty large coals for delivery over the first six months, but their ideas of prices are materially below what collieries or middlemen are prepared to sell at.

Coalfield Items.

No doubt the fact that T. Beynon and Co. have secured 50,000 tons of the Egyptian State Railway's requirements is responsible for the reopening of the Benyon Colliery at Blaina, which has been at a standstill for many weeks. Under normal conditions this colliery employs about 1500 workmen, the majority of whom were signed on at the end of last week. Efforts are also being made to bring about a resumption of work at the Main Colliery, Skewen, which has been idle for several months, and hopes are entertained that they will ultimately be successful, and that an early restart will be arranged. Developments are in progress at collieries under the Cambrian Combine, and last week two new seams were struck, while a third is expected to be struck shortly. At the Llewelyn pit of the Britannia Collieries, Gilfach Goch, the 6ft. seam of steam coal has been found after two years' hard work, while the 9ft. seam has been struck at the Anthony pit of the Naval Collieries, Penygraig, and at the Ely Colliery adjoining the Pentre seam it is expected that the seam will be reached very quickly. These developments are the cause of very considerable satisfaction in the district, as it means extra employment.

South Wales Traffic Returns.

The Great Western Railway Company's returns of traffic at the docks in this district under its control show that for the four weeks ended November 29th imports totalled 410,984 tons, a decrease of 21,730 tons, as compared with the four previous weeks. Exports amounted to 2,447,760 tons, which was an advance of 350,529 tons upon the previous month, so that the net gain in respect of imports and exports combined was 328,799 tons. During the month of November there was an improvement in coal exports at all the ports, and in the case of Barry the increased shipments came to no less than 142,647 tons. Patent fuel also marked an increase of 18,999 tons. Taking the returns for the whole of the year to November 29th, the figures compare very unfavourably with those for the same period of last year. Exports totalled 27,025,027 tons, or less by 4,636,833 tons than last year, while imports amounting to 4,859,450 tons are down by 667,659 tons, which means that the total decline is 5,334,492 tons. Coal and coke exports alone have fallen off to the extent of 4,777,298 tons in the period mentioned.

Dry Dock Amalgamation.

No official statement has yet been issued, but there is good reason for stating that before very long the amalgamation of the Mountstuart Dry Docks and Shearman's, Ltd., and the firm of Elliot and Jeffery, will be an accomplished fact. The Mountstuart undertaking owns dry docks at Cardiff, Newport and Avonmouth, and has engineering works at other ports in this district. Elliot and Jeffery are the owners of the Windsor Slipway, situated between Cardiff and Penarth, and engineering shops at Cardiff and Barry. The Mountstuart Dry Docks and Shearman's, Ltd., has a capital of £725,000, while Elliot and Jeffery is a private concern with a capital of £60,000.

Current Business.

Although there is not much fresh business passing the tone of the market is steady for large and very firm for small coals. Business for the moment is largely confined to picking up small parcels of coals in order to complete cargoes which shippers are very anxious to get away before the holidays. Coals of almost all descriptions are rather difficult to obtain, but the feature is the strength of the small coal market, which is up to 15s. for the best and is really almost nominal. Patent fuel and coke remain steady and pitwood is firm, as supplies are none too plentiful. Anthracite coals display a rather more irregular appearance, though sized qualities are very steady.

EDUCATIONAL INTELLIGENCE.

THE Council of the University of Sheffield, at its meeting on December 11th, Colonel H. K. Stephenson, D.S.O., LL.D., D.L., in the chair, appointed Mr. J. Sinclair, M.Eng., to a lectureship in mining.

THE Institution of Naval Architects announces that the following scholarships will be offered for competition in 1926:—Naval Architecture: "Martell" Scholarship (£130 per annum), and the "Vickers" Scholarship (£150 per annum). Marine Engineering: "Yarrow" Scholarship (£100 per annum), and the "Denny" Scholarship (£75 per annum), open to boys (British subjects) from approved public schools or schools under the education authorities. With the exception of the "Denny" these scholarships are open to British apprentices or students who have not yet entered upon a university course, and are tenable (subject to the regulations governing each scholarship) for four years at Glasgow University (with which is affiliated the Royal Technical College, Glasgow) for marine engineering scholarships only, and for three years at Durham University (Armstrong College), Liverpool University, the Royal Naval College (Greenwich) for naval architecture scholarships only, and the City and Guilds (Engineering) College for marine engineering scholarships only (Imperial College of Science and Technology, London). Full particulars may be obtained from the Secretary, Institution of Naval Architects, 5, Adelphi-terrace, London, W.C. 2.

LAUNCHES AND TRIAL TRIPS.

CITY OF WELLINGTON, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of the Ellerman Lines, Ltd.; dimensions, 426ft. 6in. by 54ft. 9in. by 32ft.; 7200 gross tonnage. Engines, triple-expansion, 24in., 41½in., 72in. by 51in. stroke; constructed by the builders; trial trip, November 13th.

CRISTALES, single-screw steamer; built by Cammell, Laird and Co., Ltd., to the order of Elders and Fyffes, Ltd.; dimensions, 400ft. by 51ft. by 32ft. 11in. Engines, triple-expansion, reciprocating, 27½in., 46½in. and 78in. diameter by 54in. stroke, pressure 210 lb.; constructed by the builders; launch, November 17th.

LANGLEEFORD, steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of the Medomsley Steam Shipping Company, Ltd.; 7800 tons deadweight. Engines, triple-expansion; constructed by the builders; trial trip, November 20th.

LEVERN BANK, motor ship; built by Harland and Wolff, Ltd., to the order of the Bank Line, Ltd.; dimensions, 434ft. by 53ft. 9in. by 37ft. Engines, Harland-B. and W. four-cycle motors; constructed by the builders; delivered November 23rd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that the fire which recently occurred at the G.E.C., Conduit Works—the Oriental Tube Company, Ltd., of West Bromwich—will not affect the General Electric Company's delivery service of conduits.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	21/-
(1) Spanish	18/6
(1) N. African	18/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/-

PIG IRON.

	Home.	Export.
	£ s. d.	£ s. d.
(2) SCOTLAND—		
Hematite	3 17 6	—
No. 1 Foundry	3 19 6 to 4 2 0	
No. 3 Foundry	3 17 6 to 3 19 0	
N.E. COAST—		
Hematite Mixed Nos.	3 16 0	3 16 0
No. 1	3 16 6	3 16 6
Cleveland—		
No. 1	3 9 0	3 9 6
Silicious Iron	3 9 0	3 9 6
No. 3 G.M.B	3 6 6	3 7 0
No. 4 Foundry	3 5 6	3 6 0
No. 4 Forge	3 5 0	3 5 6
Mottled	3 4 6	3 5 0
White	3 4 6	3 5 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 2 0 to 3 2 6	
„ Forge	2 16 0	—
(3) Derbyshire—		
No. 3 Foundry	3 5 0 to 3 6 0	
Forge	3 2 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 0 (a) / 4 10 6 (b) / 4 15 6 (c)	— / — / —

MANUFACTURED IRON.

	Home.	Export.
	£ s. d.	£ s. d.
SCOTLAND—		
Crown Bars	11 5 0	—
Best „	—	—
N.E. COAST—		
Common Bars	11 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	11 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home.	(7) Export.
	£ s. d.	£ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up.	7 10 0 to 7 12 6	
Sections	7 0 0 to 7 2 6	
Steel Sheets, under 9/16in. to ½in.	9 2 6 to 9 5 0	
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (*continued*).

	Home.	Export.
N.E. COAST—	£ s. d.	£ s. d.
Ship Plates	7 5 0	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light „	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
MANCHESTER—		
Bars (Round)	8 5 0 to 9 0 0	
„ (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	7 17 6 to 8 5 0	
„ (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	7 17 6 to 8 0 0	
Billets and Sheet-bars	6 0 0 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 12 6 to 16 15 0	
Angles	7 2 6 to 7 7 6	
Joists	7 2 6 to 7 7 6	
Tees	8 2 6 to 8 7 6	
Bridge and Tank Plates	7 17 6 to 8 0 0	
Boiler Plates	11 0 0 to 12 0 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/9 to 20/-
Block Tin (cash)	275 15 0
„ (three months)	272 5 0
Copper (cash)	59 0 0
„ (three months)	60 0 0
Spanish Lead (cash)	33 16 3
„ (three months)	33 15 0
Spelter (cash)	37 2 6
„ (three months)	36 10 0
MANCHESTER—	
Copper, Best Selected Ingots	64 5 0
„ Electrolytic	66 0 0
„ Strong Sheets	90 0 0
„ Tubes (Basis Price)	0 1 1
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	35 15 0
„ Foreign	34 15 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/8 to 1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	6/-
„ 6 p.c. to 8 p.c. „	£23 0 0	7/9
„ 8 p.c. to 10 p.c. „	£22 10 0	7/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£40 10 0	15/-
„ „ 1 p.c. „	£50 0 0	17/-
„ „ 0.70 p.c. carbon	£56 10 0	19/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	3/9 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
„ „ 75 p.c.	£21 0 0 scale 6/- per unit	
„ Vanadium	15/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£172 to £177	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/6
„ „ Ell	16/6
„ „ Splint	17/- to 19/-
„ „ Trebles	17/9
„ „ Doubles	16/9
„ „ Singles	14/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	15/6
„ „ Splints	17/-
„ „ Trebles	17/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/- to 15/4½
Screened Navigation	20/9
Trebles	18/- to 19/-
Doubles	16/6
Singles	15/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	15/-
Secondary Steam	14/6
Trebles	13/7½
Doubles	16/6
Singles	15/-

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		23/6
Household		40/- to 45/-
Coke		26/-
NORTHUMBERLAND—		
Best Steams		15/6
Second Steams		14/6
Steam Smalls		9/6 to 10/-
Unscreened		14/-
Household		20/- to 22/-
DURHAM—		
Best Gas		15/- to 16/6
Second		14/6 to 15/-
Household		20/- to 22/-
Foundry Coke		20/- to 22/6
SHEFFIELD—		
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 27/6	—
„ „ House	23/- to 25/-	—
„ „ Large Nuts	17/- to 20/-	—
„ „ Small	12/6 to 14/-	—
Yorkshire Hards	16/6 to 19/6	—
Derbyshire „	16/- to 19/-	—
Rough Slacks	9/6 to 12/6	—
Nutty „	6/- to 7/6	—
Smalls	3/6 to 5/6	—
Blast-furnace Coke (Inland)*	—	—
„ „ (Export)	f.o.b.	19/3 to 19/9

CARDIFF— (9) SOUTH WALES

Steam Coals:	
Best Smokeless Large	23/- to 23/6
Second „ „	21/6 to 22/6
Best Dry Large	21/6 to 22/6
Ordinary Dry Large	20/- to 21/-
Best Black Vein Large	20/- to 20/6
Western Valley „	19/- to 20/-
Best Eastern Valley Large	19/- to 19/6
Ordinary „ „	18/9 to 19/-
Best Steam Smalls	14/- to 15/-
Ordinary „	11/- to 13/-
Washed Nuts	19/- to 29/6
No. 3 Rhondda Large	27/- to 28/-
„ „ Smalls	16/6 to 17/6
No. 2 „ Large	17/6 to 18/6
„ „ Through	15/6 to 16 6
„ „ Smalls	10/6 to 11/-
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/- to 22/-
Pitwood (ex ship)	32/- to 32/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	38/- to 42/-
Seconds	32/6 to 36/-
Red Vein	27/6 to 31/-
Machine-made Cobbles	55/- to 57/6
Nuts	55/- to 57 6
Beans	42/6 to 45/-
Peas	20/- to 24/-
Breaker Duff	8/- to 8/6
Rubbly Culm	12/- to 12 3
Steam Coals:	
Large	22/- to 23 6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/6 to 18/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Iron and Steel Activity.

WHILE all other branches of trade are seriously affected by the continued depreciation of the franc and by the proposed heavy increase in taxation, the iron and steel industries are benefiting from a considerable demand that is likely to keep them actively employed for a long while to come. The fall in currency values naturally stimulates speculative buying from abroad, and a large amount of business has been transacted for export in the belief that the depreciation will continue, but past experience has shown that, if these predictions should fail to be realised, there will be eventually a cancelling of contracts against which makers have little or no remedy. In the same way, the general belief in a steady increase of prices all round, owing to the imposition of heavy taxes, has induced home consumers to commit themselves as far forward as possible. Iron and steel firms have therefore plenty of orders on their books, and they now refuse to enter into contracts for delivery too far ahead. It is probable that this buying will become less active when stocks begin to accumulate, for the production is far in excess of immediate requirements, and nearly all branches of the engineering trades are slowing down as the result of the somewhat dubious outlook.

Russian Trade.

The possibility of resuming trade with Russia has always appealed to manufacturers, and the Soviet propaganda in favour of promoting commercial relations is successful to a certain extent, although it will be found on analysis of the statistics, published to prove the advantage of doing business with Russia, that the benefit, so far, is all on the side of the Soviet, which has every reason to keep on good terms with a market that is taking increasing quantities of Russian products. French manufacturers are by no means assured that they will derive much profit from succumbing to the blandishments of the Soviet representatives, and at a recent Congress of commercial associations it was stated that French agents in Russia are so bound down with hostile restrictions that they find it hopeless to attempt to do business. The Congress, therefore, recommended the Government to enter into no commercial arrangement with the Soviet which did not offer absolute reciprocity and which did not take into account a settlement of the debts.

Trans-Pyrenean Railways.

The construction of new railways has been greatly retarded by the operation of a convention dating as far back as 1883, whereby the companies were to contribute 25,000 francs per kilometre to the cost of the permanent way, and the State was to pay the remainder on condition that the total cost did not exceed 90,000 francs per kilometre. As the cost to-day is at least three times as much as it was at the time the convention was entered into, the railway companies are unable to start upon constructions which would necessitate their paying the difference, and for that reason nothing has been done during the past three years with the two lines which are to cross the Pyrenees and will, in one case, shorten the distance between Toulouse and Barcelona by 66 miles. The carrying out of this work has been rendered more urgent, and will be greatly simplified, by the electrification of the Midi line, and an arrangement has therefore been come to between the Compagnie du Midi and the State whereby the maximum cost per kilometre will be increased to 250,000 francs. At the same time all the difficulties that have hitherto existed between France and Spain over the methods of connecting up the two systems have been settled, and it is stated that work will be started as soon as possible upon the Ax-les-Thermes and Bedous lines, beginning with a line from Bourg-Madame to Tour-de-Carel, which will bring the material necessary for the construction of the Ax-les-Thermes Railway. France will have an international station at Tour-de-Carol and Spain at Puigcerda. The lines will also be electrified on the Spanish side, but the trouble due to difference of gauge will remain.

Carbonising Plants.

Suction gas from charcoal is the only practical form of native fuel that has yet been found to supplement petrol for heavy motor vehicles, and there can be little hope of its being employed extensively until ample supplies of charcoal are assured at a sufficiently low price. It is believed that a solution of the problem lies in the invention of portable carbonising plants which will allow of charcoal being made out of brushwood, and at trials of such apparatus held in the Forest of Senart last July, the results obtained were promising, although some of the plants failed to comply with the requirements, particularly as regards portability and handiness. Other trials are to be held in a pine forest near Bordeaux in June next. There will be a category of simple carbonising plants and another of such plants combined with apparatus for the revovery of by-products. Portability is not regarded as an essential feature of these plants. After the trials they will be exhibited at the Bordeaux Fair, and at the same time there will be demonstrations of motor vehicles running on suction gas.

Machinery Trade.

A summary of the foreign trade returns during the first nine months of the year shows that there has been of late years a steady decline in the importation of machinery and a notable expansion of exports. The machinery imports fell from 188,000 tons in the first nine months of 1924 to 150,000 tons during the similar period of this year, but the values were slightly higher, owing, of course, to the depreciation of the franc. The estimated value this year was 1170 million francs. The exports of machinery during the nine months totalled 505,000 tons, as compared with 351,000 tons in the corresponding period of 1924. The values increased from 1679 million francs in 1924 to 2037 million francs this year. The machinery imported came chiefly from Switzerland and Germany, the supplies from the latter country being on account of reparations.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

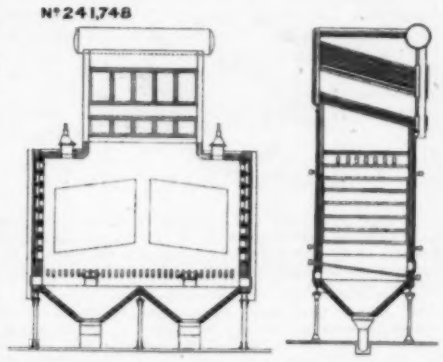
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

241,748. December 11th, 1924.—BURNING PULVERISED FUEL, Vickers and International Combustion Engineering Company and F. H. Rosencrantz, Africa House, Kingsway, London, W.C.

This invention is described in the specification as follows:—

N° 241,748



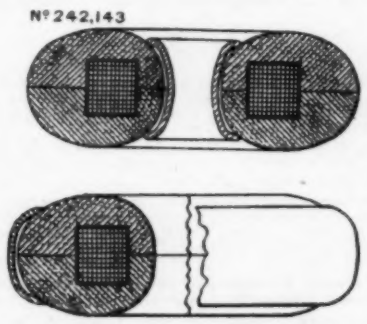
"A furnace arrangement for water-tube boilers of the cross drum type adapted to burn pulverised fuel, wherein the pulverised fuel is fed into the furnace at one or both of the sides of the boiler that extend transversely to the boiler drum or drums, through an appropriate burner or burners fitted in a side arch or side arches."—*October 29th*, 1925.

ELECTRICAL APPLIANCES.

242,143. March 9th, 1925.—INDUCTANCE COILS, *Western Electric Company, Connaught House, Aldwych, London, W.C. 2.*

The object of this invention is to provide an economical and efficient method for mechanically fastening the two halves of ironclad inductance coils together. The coils of the particular type to which this invention is applicable consist of the toroidal ironclad type of loading coil, in which an inductance winding is embedded in and between two annular rings of iron dust material, which not only greatly resists drilling for fastening the two halves of the ring together, but also destroys the drills by grinding

N° 242,143



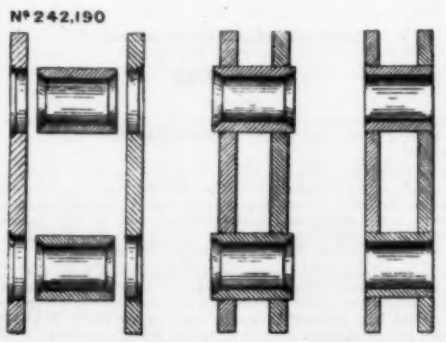
them away. There is also danger of cracking and checking in the material during drilling. This invention provides a means for fastening the two halves of the ring together without drilling or otherwise altering the material of the ring, by inserting a short length of metal tubing in the centre of the ring and expanding its ends until they clamp the ring halves securely. In a similar manner, the ring halves may be fastened together by means of a larger tube spun over the outer edge of the ring. The alternative methods of fastening are shown separately in the illustration. —*November 5th*, 1925.

TRANSMISSION OF POWER.

242,190. May 27th, 1925.—FLAT LINK SPROCKET CHAINS, The Coventry Chain Company, Ltd., and R. S. Cattanach, Spon End Works, Coventry.

This invention relates to chains for power transmission, of

N° 242,190



the kind in which each alternate link consists of a pair of side plates connected together by a pair of bushes. Usually, these bushes are a press fit in the side plates, but under certain conditions a construction of this kind is inadequate and likely to cause failures. The inventor consequently countersinks the holes in the plates and rivets the bushes in place, as shown in the illustration.—*November 5th*, 1925.

MEASURING AND TESTING INSTRUMENTS.

242,450. November 22nd, 1924.—MEASURING AREAS, Norton and Gregory, Ltd., Castle-lane, Buckingham Gate, London, S.W. 1; L. Sarl, 7, South George-street, Dundee; and E. W. Crisp, 26, Sedgemere-avenue, East Finchley, London, N.

This instrument for measuring the areas of irregular figures is so divided that it gives a direct reading of the approximate

N° 242,450

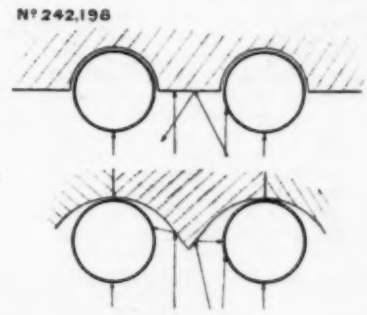
area of separate sector-shaped pieces of the figure. The instrument is set with the pivot A somewhere about the centre of the figure, and is rotated in steps of 18 deg. with the assistance of the graduations B B. The intersection of the boundary of the figure with the markings C on the stem indicates directly the area of the sector. By taking a number of readings and summing them the total area is obtained.—*November 12th*, 1925.

FURNACES.

242,198. June 26th, 1925.—WATER-COOLED WALLS, The Stirling Boiler Company, 32, Farringdon-street, London, E.C. 4, and H. S. Horsman, 140, Albert Palace-mansions, Battersea Park, London, S.W. 11.

Ordinarily in furnaces having water-cooled walls with the tubes disposed on the inner side of the brickwork, the radiant heat from the fuel strikes the brickwork adjacent to the tubes,

N° 242,198



and some of the rays are absorbed by the brickwork. The majority are, however, reflected back to the fuel bed, the temperature of which will depend to some extent upon the amount of heat returned in this way. The inventors dispose the cooling tubes in comparatively shallow, broad, corrugations in the brickwork, the surfaces of which, they claim, reflect practically all the radiant heat on to the tubes, as shown in the lower of the two illustrations.—*November 5th*, 1925.

MINING MACHINERY.

242,188. May 26th, 1925.—COAL SCREENING, *A. Woosnam, 10, New Court, Lincoln's Inn, London, W.C. 2.*

This machine is intended for the separation of minerals or

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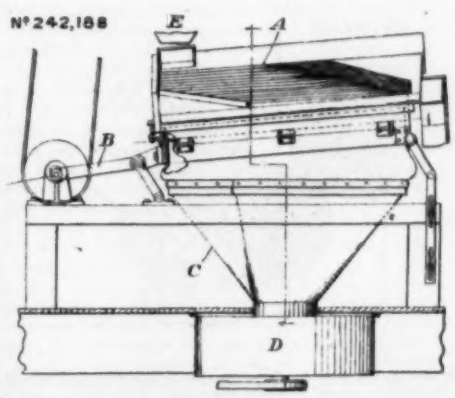


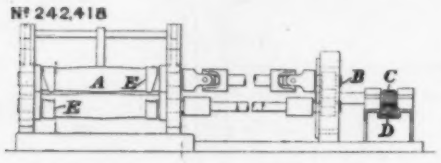
the dry cleaning of coal. It takes the form of a jigging screen A operated by the gear B and mounted over an air trunk C. It is, by the way, said that the angle of the conical part of this trunk

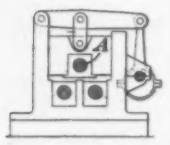
must be less than 40 deg. The joint between the screen is made air-tight and flexible, and a fan D forces a draught of air upwards. The material to be classified is fed on to the higher part of the screen by the shoot E, and the combined action of the jigging and the air current is such that the lighter particles jump over the riffles of the screen and are discharged towards the left, while the heavier stuff travels along and is discharged on the right.—*November 5th*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

242,418. October 20th, 1924.—MANUFACTURE OF AXLES, G. Baker, Greno House, Swinton, near Rotherham.

This machine is intended for rolling axles, from billets, by inserting the billet between three co-axial rolls. The upper roll A is mounted in sliding bearings, so that it can be raised for the insertion of the billet, as shown in the cross-sectional drawing. The rolls are all driven and are given an oscillating movement



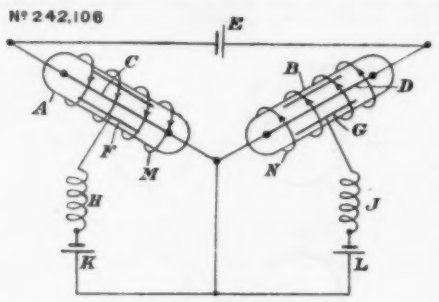


by means of the gearing B, and a pinion C meshing with a reciprocating rack D. The chief peculiarity of the machine lies in the arrangements made for the formation of the journals and collars. Instead of these parts being formed by continuous circumferential projections on the rolls, they are shaped by non-continuous, segmental tapered projections, as shown at E, which act on the metal progressively.—*November 12th*, 1925.

SHIPS AND BOATS.

242,106. December 20th, 1924.—AUTOMATIC STEERING, *J. W. Kirkland, Crown House, Aldwych, London, W.C. 2.*

This apparatus is intended to take the place of a gyroscopic compass in automatically keeping a ship on her course. It comprises two "Magnetrons" A and B, which act as valves, preventing the passage of current when a magnetic field, existing in a well-defined direction within the tube, exceeds a certain strength. The two magnetrons are set at an angle, with regard to the keel, as shown. The cathodes C D are heated by current from a source E and send out electrons which pass to the anodes

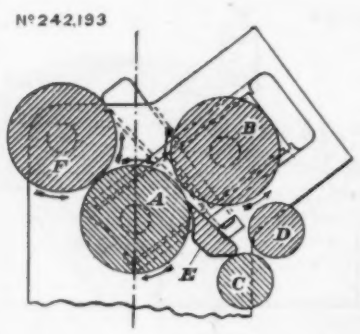


F and G. The circuits are completed through relays H and J, and sources of current K and L. By correct adjustment of the strength of current in solenoids M and N, the two magnetron tubes can be rendered currentless in the position shown. The field produced by the solenoids is in opposite directions in the two magnetrons. When therefore the ship deviates from its set course, the magnetic field in one magnetron is weakened by the earth's field, while in the other it is strengthened. The magnetron with the weakened field permits the passage of current thus energising the corresponding relay which causes the rudder motor to operate.—*November 5th*, 1925.

MISCELLANEOUS.

242,193. June 8th, 1925.—GLASS ROLLING MACHINERY, W. H. Robson, 37, Cardigan-place, Albert Park, Victoria, and H. M. Leggo, 218, Queen-street, Melbourne.

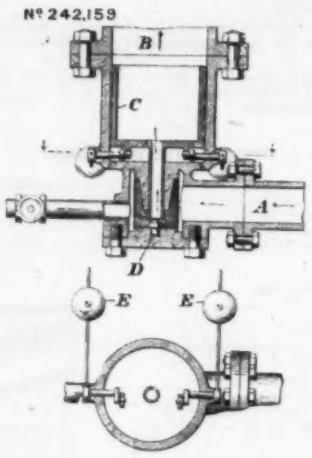
This invention is intended to overcome the difficulties experienced with glass rolling machines, on account of the teeming plate becoming overheated and distorted. The two primary



rolls are shown at A and B, while the finishing or figuring rolls are marked C and D. Between them there is the centre plate E. By the addition of another roll F a hopper-like recess is formed above the primary rolls, which serves to receive the molten glass and does not become overheated. All the rolls are, of course, driven in appropriate directions.—*November 5th*, 1925.

242,159. April 3rd, 1925.—REDUCING VALVES, J. E. Boggiano, 36, West 71st-street, New York, U.S.A.

In this reducing valve the inlet is at A and the low-pressure outlet at B. In the outlet branch there is a hollow piston C with a hollow stem projecting into the high-pressure casing and



co-acting with a valve D. The weight of the piston is counterbalanced by levers and weights E E. By adjusting these weights the position of the piston stem with regard to the valve D can be regulated and the throttling effect of the valve thus controlled.—*November 5th*, 1925.

242,520. March 31st, 1925.—LUBRICANTS, R. Birkbeck, 46, Cavendish-street, Darwen; E. Birkbeck, 38, Greenway-street, Darwen; and G. E. Webster, 5, Holden-fold, Darwen.

The inventors propose to use a mixture in the following proportions by weight:—Lard 16, mercury 16, suet 1, sulphur 40, and castor oil 24, as an addition to ordinary lubricating oil, at the rate of 4 oz. of mixture per gallon of oil. First the lard is well pounded and worked into the mercury, after which prepared suet is intimately worked into the mixture, adding sufficient castor oil to ensure an even and easy coagulation of the substances. When a thin paste or cream of the mixed substances is obtained, the sulphur is subsequently added and worked intimately into the cream, after which more castor oil is added to obtain the creamy consistency.—*November 12th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "The Steam Locomotive and its Future in relation to Electric Traction," by Mr. T. H. Shields. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—15, Savoy-hill, Strand, London, W.C. 2. Lecture and demonstration of industrial and domestic electric lighting. 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Papers, "Some Aspects of the Theory of Ship Waves and Wave Resistance," by Professor T. H. Havelock. 7.30 p.m.

POLYTECHNIC ENGINEERING SOCIETY.—Fyvie Hall, 309, Regent-street, London, W. 1. Annual Conversazione. 7.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Room 24, Royal Technical College, George-street, Glasgow. "Speed Control in Relation to Modern Rolling Mill Drives," by Mr. L. Rothera. 7 p.m.

MONDAY, DECEMBER 21ST.

WHITWORTH SOCIETY.—Holborn Restaurant, Kingsway W.C. 1. Third annual commemoration dinner. 6.30 for 7 p.m.

TUESDAY, DECEMBER 22ND.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, London, E. 1. Paper, "Fuel Injection," by Mr. C. Hughes. 6.30 p.m.

WEDNESDAY, DECEMBER 30TH.

ROYAL AERONAUTICAL SOCIETY.—7, Albemarle-street, London, W. 1. Special general meeting of voting members. 5.30 p.m.

CONTRACTS.

WE are informed that the new electric cars on order for the Leeds City Tramways are to be equipped with "Hoffmann" bearings.

HOLLINGS AND GUEST, Ltd., of Thimble Mill-lane, Birmingham, have recently received two orders for the supply of hydraulic plant to the High Commissioner for India, comprising bending presses, a flanging press, a briquetting press, an axle forcing press, and an ingot breaker, to be installed at the East India Railway Locomotive Works at Lucknow and Jamalpur.

WE are informed by International Combustion, Ltd., that its French associated company, La Société Anonyme des Foyers Automatiques, of Paris, has recently received orders for Lopulco pulverised fuel equipment for (*a*) four boilers, each of 13,000 square feet of heating surface; (*b*) two boilers, each of 11 000 square feet of heating surface; (*c*) an annealing furnace of thirteen ovens; (*d*) two Ladd-Belleville boilers, each of 9000 square feet of heating surface; (*e*) for five air reheaters, each having an area of 17,000 square feet; and (*f*) for six suspended arches.

Catalogues.

MANLOVE, ALLIOTT AND CO., Ltd., Nottingham.—Monthly wall calendar.

COLE, MARCHENT AND MORLEY, Ltd., Bradford, Yorkshire.—Leaflet on heat extraction.

MACREADY'S METAL COMPANY, Ltd., 7, Baron-street, N. 1.—No. 2 London stock and price list.

JOHN BENNIE, Ltd., Moncur-street, Glasgow.—Leaflet showing the various types of lifts installed.

CROMPTON AND CO., Ltd., Chelmsford, Essex.—Descriptive list No. 607 of auto-synchronous motors.

WYSS AND CIE., Seloncourt, France.—Leaflets illustrating the Wyss automatic belt tightening device.

EWART AND SON, Ltd., 346, Euston-road, N.W. 1.—Descriptive price lists of Ewart's "Emperor" cowl.

THE ANDERSON GRICE COMPANY, Ltd., Carnoustie, Scotland.—Pamphlet dealing with electric derrick cranes.

HOBDELL, WAY AND CO., Ltd., 45, Church-street, E. 1.—Booklet illustrating the uses of Petro-Flex tubing.

GUMMERS, Ltd., Rotherham.—No. 25 revised steam specialties catalogue, covering valves and boiler mountings.

SUMET METAL CORPORATION, Ltd., 39, Grosvenor-place, S.W. 1.—Booklet dealing with "Sumet" bearing metals.

RANSOMES, SIMS AND JEFFERIES, Ltd., Ipswich.—Booklet on Ransomes' "Orwell" electric industrial trucks.

DRUMMOND BROTHERS, Ltd., Rydes Hill, Guildford.—Descriptive booklet of the "H.A." type sensitive radial drill.

O. N. BECK, 11, Queen Victoria-street, E.C. 4.—Leaflet dealing with the "Opifex" water level communicator.

J. HOPKINSON AND CO., Ltd., Britannia Works, Huddersfield.—List No. 1850, dealing with the "Mac" valve.

F. BRADY AND CO., Ltd., Petershill-road, Glasgow.—Steel storage bin catalogue and a new steel structural catalogue.

THE B.E.N. PATENTS, 100, Victoria-street, S.W. 1.—Folder giving particulars of the "Speedway" portable electric saw.

J. W. BROOKE AND CO., Ltd., Adrian Works, Lowestoft.—Catalogue No. M.M./25, entitled "Brooke Marine Motors, 1925."

OERLIKON Ltd., 28–31, Essex-street, W.C. 2.—Monthly number of the *Oerlikon Bulletin*, describing the firm's activities.

BURTON, GRIFFITHS AND CO., Ltd., 64–70, Vauxhall Bridge-road, S.W. 1.—Catalogue No. 29A of Brown and Sharpe small tools.

FERRANTI, Ltd., Hollinwood, Lancashire.—Pamphlet Ta 710, describing short-circuit tests on a 1200-kilovolt-ampère transformer.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, East Pittsburgh, U.S.A.—Booklet entitled "Line Material for Mines."

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 170, Piccadilly, W. 1.—Brochure dealing with electric rivet heating machines.

BOWEN INSTRUMENT COMPANY, 9, Newton-road, Leeds.—Circular C. 32, illustrating and describing the "Pyro" radiation pyrometer.

JOSEPH ADAMSON AND CO., Hyde, Cheshire.—Pamphlet illustrating and describing the horizontal flame tube type waste heat boiler.

PATERSON HUGHES ENGINEERING COMPANY, Ltd., Lochburn-road, Glasgow.—List No. 5, describing the "Clyde" screw pile driving machine.

HERBERT MORRIS, Ltd., Loughborough.—Illustrated folder giving various types of overhead runways with their working loads and prices.

MARSHALL, SONS AND CO., Ltd., Britannia Ironworks, Gainsborough.—Publication No. 1503, describing the "Marshall" steam road roller.

DUBILIER CONDENSER COMPANY (1925), Ltd., Victoria-road, North Acton, W. 3.—Booklet describing the firm's works and some of their products.

ALLOY WELDING PROCESSES, Ltd., 14–16, Church-street, Islington, London, N. 1.—Bulletin No. 50, entitled "Why the Flux-coated Electrode."

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Lockwood, Huddersfield.—Brochure describing the "D.B.S." worm drive applied to motor vehicles.

EDGAR ALLEN AND CO., Ltd., Imperial Steel Works, Sheffield.—Seventh revised edition of catalogue D, entitled "Steels for Motor Cars and Aircraft."

AUTOMATIC AND ELECTRIC FURNACES, Ltd., 173, Farringdon-road, E.C. 1.—Catalogue dealing with "Wild-Barfield" electrically heated industrial ovens.

CHARLES CHURCHILL AND CO., Ltd., 9–15, Leonard-street, E.C. 2.—Particulars of the Warner and Swasey No. 1A universal hollow hexagon turret lathe.

MILLARS' MACHINERY COMPANY, Ltd., 95, Bothwell-street, Glasgow.—Folder containing examples of the catalogues issued on the company's various manufactures.

THE RANSOME MACHINERY COMPANY (1920), Ltd., 42–50, Victoria-street, S.W. 1.—Catalogue No. 39, describing the "Ransome" standard type concrete mixer.

THE SKEFKO BALL BEARING COMPANY, Ltd., Luton.—Price lists of the self-aligning ball-bearing rigid housings and self-aligning ball-bearing angle plummer blocks.

THE DOMINION RUBBER COMPANY, Ltd., 47, Farringdon-street, E.C. 4.—Leaflet illustrating a large "Matchless" conveyor belt supplied to the Chilean nitrate fields.

THE HORSELEY BRIDGE AND ENGINEERING COMPANY, Ltd., Dudley Port, Tipton, Staffs.—An interesting brochure published by the company, which deals briefly with its history and activities.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester.—Leaflet 18/1–1, describing direct-current mill motors; leaflet 17/1–1A, describing direct-current commutating pole motors.

THE MIDLAND ELECTRIC MANUFACTURING COMPANY, Ltd., Barford-street, Birmingham.—Pamphlet dealing with the various public regulations applying to the design, installation and use of ironclad switch and fuse gear.

G. CUSSONS, Ltd., Lower Broughton, Manchester.—Folder 524, illustrating the general range of the firm's products, also handbooks, entitled "Accurate Screw Pitch Measurement" and "Form and Shape of Screw Threads."

THE SUPERHEATER COMPANY, Ltd., 195, Strand, W.C. 2.—A loose leaf catalogue containing a large number of pamphlets dealing with the various superheater installations by the company in power plants, ships, and locomotives.

B. AND S. MASSEY, Ltd., Openshaw, Manchester.—Catalogue No. 2850 H, describing double-acting steam stamps of the arch form. No. 2860 H, dealing with pneumatic power hammers steam hammers, and sundry special machines.

A Seven-Day Journal

Imperial Airways' New Agreement.

ACCORDING to a statement made in the House of Commons by the Secretary for Air, the subsidy agreement under which Imperial Airways has been operating its commercial aeroplane services since April 1st, 1924, is to be replaced by another embodying an important change in one of the requirements. Under the original agreement the company was required to show a total flying mileage of at least 800,000 miles a year during each of the first four years and 1,000,000 miles per year thereafter. Incidentally, it may be mentioned that during the first year of its existence it succeeded in fulfilling this requirement, the number of miles flown having been about 828,000. The stipulation of a minimum machine mileage has, it is found, resulted in a premium being placed upon the use of small machines. In order to encourage the attainment of economy and efficiency, the new agreement seeks to reverse matters, and encourage the use of high-powered machines in place of a larger number of smaller machines of equivalent capacity. To achieve this end, the requirement of 1,000,000 miles a year is to be replaced by what is regarded as its fair equivalent, namely, 425 million horse-power miles. The mileage of a high-power machine will, under this new arrangement, clearly count far more towards the realisation of the subsidy conditions than an equal mileage flown by a small machine. The amount of the subsidy and the general provisions of the original agreement are to remain unaltered. It is understood that the figure for the horse-power miles to be flown was arrived at by taking 425 horse-power as the average power of the machines at present in the company's service.

Egypt-India Air Services.

ON the same occasion Sir Samuel Hoare made another announcement concerning the development of the work undertaken by Imperial Airways. An agreement, he intimated, was being negotiated with the company under which it would be made responsible for the operation of a fortnightly service for passengers, mails and freight between Egypt and India, *viâ* Baghdad and Basra. The agreement would last for five years, and the maximum annual subsidy to be earned under it would be £93,600. It was not anticipated that the service would be in operation before the end of 1926. At a later date, it was hoped, the service would become a weekly one. In contrast with the original agreement with Imperial Airways referred to in the preceding paragraph, the new agreement for the Egypt-India service makes a definite stipulation regarding the type of machine to be used. In view of the unfrequented nature of the bigger part of the route to be traversed, it is considered essential to take all possible steps to prevent forced landings, and to that end triple-engined machines are to be employed. Machines of this description have already been constructed, notably the Handley Page Hamilton biplane and its more recent edition, the Hampstead. Others of the same class are now under construction by A. V. Roe and Co., Ltd., and Sir W. G. Armstrong, Whitworth and Co., Ltd. Both these types will be driven by radial air-cooled engines, and are particularly intended for use under Middle East conditions. A large three-engined all-metal cantilever monoplane is being built by William Beardmore and Co., Ltd., for experimental purposes, and another three-engined monoplane is being built by Handley Page, Ltd.

Electricity Charges.

PROTESTS were made at several of the annual wardmotes held this week concerning the high prices charged for electricity in the City of London. At that held for the Ward of Candlewick, Deputy Alderman C. G. Algar moved a resolution protesting against the excessive charges made by the two companies supplying the City, in comparison with those made by adjacent boroughs. He instanced the case of a large firm in St. Paul's Churchyard, which in three years paid £2578 more than it would if it had been supplied by the Stepney Borough Council. For the years 1919–1924, one of the City companies declared in dividends, bonus and bonus shares 89 per cent. and allocated to reserve another 75 per cent., making a total of 164 per cent. on paid-up ordinary capital. The other company also paid 88 per cent. in dividends and placed 91 per cent. to reserve, making a total of 179 per cent. on ordinary capital. The resolution was carried unanimously.

Private Ownership of Railway Wagons.

A FORTNIGHT ago we reported the views submitted to the Coal Commission by Mr. W. T. Stephenson, of London University, regarding the private ownership of railway wagons. Mr. Stephenson stated that there were about 600,000 privately owned wagons in the kingdom, and that some 450,000 of them were used for the transport of coal. The system of private ownership was, he argued, inherited by the railways from the turnpike roads, and its abolition provided a big possibility of effecting an immediate saving in the cost of coal to the consumer. Last week Sir Ralph Wedgwood, chief general manager of the London and North-Eastern Railway, gave evidence before the Commission, and touched upon the same matter. A system of railway-owned wagons, he said, was the most economical as regarded his own railway, but he did not think the time was opportune for its universal adoption. The total economy to be realised by such universal adoption would, he estimated, range from £600,000 to £1,000,000 per year. Any such saving would amount to very little economy on the cost of a ton of coal. Even taking the largest estimated figure, he found that it would represent little more than 1d. per ton on railway-borne coke and coal. He called attention to another source of waste in the handling of coal traffic, namely, the marked growth in the number of coal merchants and coal exporters which had occurred since the war. Asked as to the probable effect on the demand for coal exercised by the development of electric traction, Sir Ralph stated that the electrification of main lines would result in a very substantial reduction in the coal consumed. He added, however, that, in his opinion, the Commission need not seriously consider the question of main line electrification during the next ten years.

A Large Marine Oil Engine.

THE largest size of Diesel oil engine yet built in this country concluded its trials at the Clydebank yard of John Brown and Co., Ltd., at the end of last week. It is of the Brown-Sulzer two-cycle single-acting type, and has been built by John Brown and Co., Ltd., in conjunction with Sulzer Brothers, of Winterthür. Work was begun on this unit nearly eighteen months ago. There are four cylinders, each with a bore of 35½in. and a stroke of 63in., and during the recent trials 4000 brake horse-power was developed at a speed of from 86 to 87 revolutions per minute. As now constructed, the new engine will form the first half of the port set of a proposed twin-screw installation which, when ordered, will comprise two sets of eight-cylinder engines, capable of maintaining at sea an output of 15,000 brake horse-power at the speed above named, this power being equivalent to a total of 19,000 indicated horse-power. The two three-stage air compressors with the two scavenging pumps will not be separately driven, but are already built on to the unit just tested. They are mounted at the forward end of the engine, and are driven from an extension of the main crank shaft. Much interest and importance attaches to this new British-built engine, which brings the two-cycle single-acting engine well up to the engine powers required for large passenger liners fitted with twin-screw propelling machinery.

Vickers Limited.

AT an extraordinary meeting of shareholders of Vickers Ltd., held in Sheffield last week, the scheme for reorganising the company which was recommended by the advisory committee, consisting of Mr. F. Dudley Docker, Mr. Reginald McKenna and Sir William Plender, was, after a short discussion, approved. It was also agreed, subject to confirmation, that certain shareholders should be associated with the advisory committee. The reorganisation scheme provides for the writing off of £12,442,366 of the company's assets, of which sum £3,600,000 is to be taken from the reserve fund, £632,044 from the credit at profit and loss, whilst the remaining £8,210,322 is to be found by reducing the nominal value of the ordinary share to 6s. 8d. Among other changes which are recommended by the advisory committee are the reconstitution of the present board of directors and the formation of three management boards, namely, an Industrial Board, an Armaments and Shipbuilding Board, and a Finance Board. As regards the future of the company, a policy of consolidation and strict economy is advocated, and the opinion of the advisers is that, provided trade prospects do not get worse, the net profits of the firm should suffice to pay debenture interest and preference dividends as well as permitting the resumption of dividend payments on the reduced ordinary share capital. The advisers have agreed to continue to act in a consultative capacity until the new management boards are working, and some further directors have been appointed. A confirmatory meeting will be held shortly, at which the names of the shareholders chosen to work with the advisory committee will be announced.

The Dolgarrog Disaster.

AT the inquest on the victims of the Dolgarrog disaster the coroner called attention to the fact that no statutory provision was in existence making it obligatory upon any Government Department to institute an inquiry into the circumstances of a failure of a dam. It was felt at the time, however, that the Home Office would be practically certain to take action in the matter, and from a statement made in Parliament on Monday we learn that it has now done so. Answering a question, the Home Secretary said that the Government had come to the conclusion that there should be a further investigation of a technical character into the site, design and construction of the two dams that gave way and of other local dams under the control of the Aluminium Corportation and the North Wales Power Company. It had been arranged, he continued, that these companies should employ an engineering firm of high standing, not hitherto connected with the dams, to hold a full investigation on the lines indicated. The firm's name would be submitted to the Government for approval and its report would be made available to it.

Safeguarding the Iron and Steel Trades.

ON Monday, in the House of Commons, the Prime Minister announced that the Government had come to the conclusion that it could not grant the application of the iron and steel trades for the appointment of a Committee under the Safeguarding of Industries Act. The application, Mr. Baldwin stated, had been referred to the Committee of Civil Research. That body had given prolonged consideration to the question and had heard a large number of witnesses representative of the employers and the employed in the iron and steel and kindred industries. The evidence, it was admitted, revealed a serious situation in the matter of foreign competition, aided by long hours, low wages, and depreciated currencies. Had it been possible to deal with the iron and steel industries in isolation, the Government might have regarded the case for an inquiry as complete. But it was established that the safeguarding of a basic industry of the magnitude of the iron and steel trades would have repercussions of a very wide character, and in all the circumstances of the present time the Government had decided not to grant the application. It would, however, Mr. Baldwin promised, keep the industries under close observation with a view to promoting their welfare should any other measures be deemed desirable. It is no secret that the proposal to apply the provisions of the Safeguarding of Industries Act to the iron and steel trades was not received with complete favour by all those engaged in it, while among engineers and others outside, but dependent upon the industry, a considerable body of opinion was distinctly hostile to it.

The Shannon Power Scheme.

THE wages paid to the workmen engaged upon the Shannon power scheme were recently discussed for two days in the Irish Senate. On behalf of the Government Mr. McGilligan stated that when all allowances were made the wages paid to those engaged on the scheme were higher than those earned by the average agricultural labourer, and the wages offered were attracting more labour than the contractors could employ. To pay the inflated rates on the Shannon scheme, as the labour leaders demanded, would merely put off the evil day of deflation by subsidising wages out of the pockets of the country's bankrupt farmers. Labour's reply to these arguments was that 50s. a week was the minimum wage on which a man could support a family decently. If production were properly organised, waste eliminated, and interests and profits kept within fair bounds there would be no difficulty about every man earning £2 10s. per week. While the arguments of the antagonists are as irreconcilable as ever, both sides are finding it necessary to make some concessions in practice. Without any consultation with labour the contractors have raised the minimum wage from 32s. to 35s. a week and are ready to promote to a higher rate of pay any man who shows himself to be a good worker.

Sydney Harbour Bridge.

SOME interesting particulars regarding the execution of the Sydney Harbour Bridge contract were given last week by Sir Arthur Dorman at the annual general meeting of the shareholders of Dorman, Long and Co., Ltd., at Middlesbrough. The work, Sir Arthur stated, was proceeding in accordance with the programme, and the fabrication and erection of the approach spans, in themselves an undertaking of no mean magnitude, would shortly be begun. In a work of the magnitude of the Sydney Bridge, however, a long time must elapse before results became visible. The terms of payment provided in the contract resulted in the firm being heavily out of pocket before it began to receive any payments of a substantial nature. The plant and buildings required had to be constructed, a quarry had to be developed, and the drawings had to be prepared. All this preliminary work had involved the expenditure of large sums of money, and indeed accounted for some £640,000 of the overdraft shown in the balance-sheet. That sum, it was estimated, would show a continuous increase for another eighteen months, but thereafter the progress payments would be on a more substantial basis, and the outstanding balance would be steadily reduced. This heavy outgoing was foreseen in framing the estimate for the bridge, and due provision was made for the interest charges on it. Work on the Newcastle Bridge had, he continued, proceeded during the year to the satisfaction of the Newcastle and Gateshead Corporations. That bridge was designed on similar lines to the Sydney Harbour Bridge, and although it was a much smaller structure, it would give the firm much valuable experience in the erection of a structure of its type.

Some Factors Affecting the Resistance of Ships in Waves.

By W. G. A. PERRING, A.M.I.N.A.

ALTHOUGH the amount of experimental data regarding the motion and resistance of ships among waves, at present available, is very meagre, yet it is hoped that an analysis of some of these experiments will bring out one or two points concerning the resistance that may be of interest, and perhaps help to explain the large variations in resistance experienced.

The results for a rather full mercantile form over a

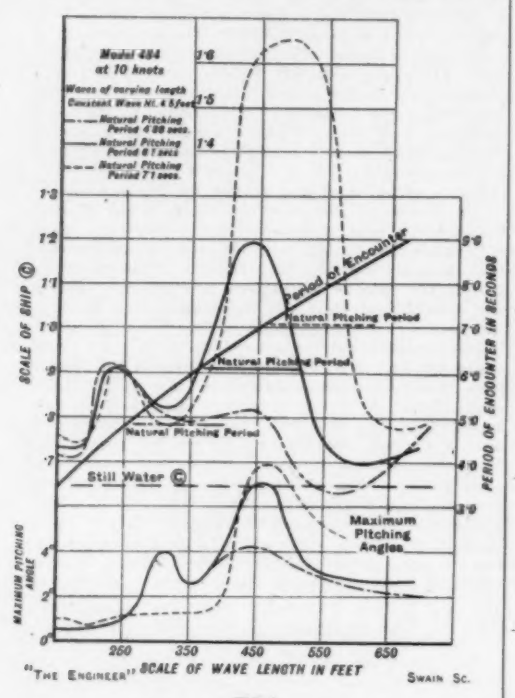

Model 484 at 10 knots
Waves of varying length Constant Wave Ht. 4.5 feet
Natural Pitching Period 4.99 secs.
Natural Pitching Period 6.1 secs.
Natural Pitching Period 7.1 secs.
Period of Encounter
Natural Pitching Period
Natural Pitching Period
Natural Pitching Period
Still Water
Maximum Pitching Angles
SCALE OF SHIP
MAXIMUM PITCHING ANGLE
PERIOD OF ENCOUNTER IN SECONDS
250 350 450 550 650
"THE ENGINEER" SCALE OF WAVE LENGTH IN FEET
SWAIN SC.

FIG. 1

range of speed, and for a variation of wave length, were given in a paper read before the Institution of Naval Architects by Mr. Kent in 1922. In all, three models, differing only very slightly at the forward end, were tried. Model 484 was the normal mercantile form, model 487A had pronounced U-shaped sections at the bow, whilst model 487B, besides having U sections, was given considerable flare above the waterline. Typical resistance curves, at 8 and 10 knots respectively, for these models, are given in Figs. 1 and 2, which, through the courtesy of Mr. Kent and the Institution of Naval Architects, are reproduced from

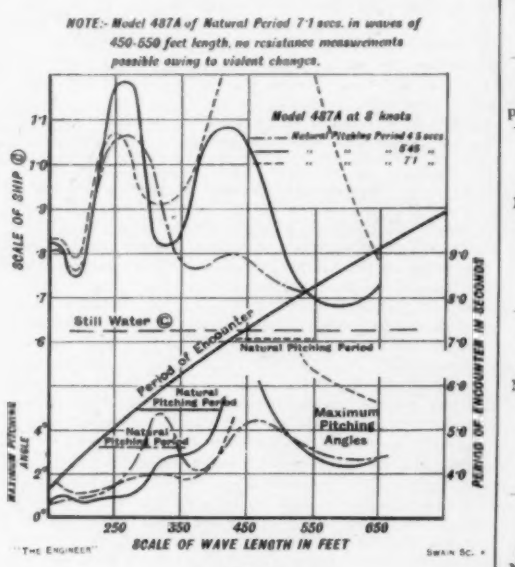

NOTE:- Model 487A of Natural Period 7·1 secs. in waves of 450-550 feet length, no resistance measurements possible owing to violent changes.
Model 487A at 8 knots
Natural Pitching Period 6·1 secs
Natural Pitching Period 7·1 secs
Still Water
Period of Encounter
Natural Pitching Period
Natural Pitching Period
Natural Pitching Period
Maximum Pitching Angles
SCALE OF SHIP
MAXIMUM PITCHING ANGLE
PERIOD OF ENCOUNTER IN SECONDS
250 350 450 550 650
"THE ENGINEER" SCALE OF WAVE LENGTH IN FEET
SWAIN SC.

FIG. 2

Mr. Kent's original paper. It will at once be noticed that the resistance suffers considerable fluctuation as the wave length increases, and that the fluctuations occur with a certain regularity despite the variation in the natural pitching period of the models, due to the conditions of loading.

The further results given in this paper vary in much the same manner, and to enable all the results to be examined at the same time, Table I. has been prepared, giving the wave length and period of encounter, at which the more pronounced features of the resistance curve occur, together with details relating to the speed and loading conditions of the models.

A further series of results relating to the resistance experienced in waves of constant length, but of varying wave heights, and at varying speeds, have been set out in Table II., and the general type of curve has also been indicated to enable the table to be more easily followed.

An examination of Table I. in conjunction with Figs. 1 and 2, shows that for all the models and for all conditions of loading of these models, a slight, and in some cases a marked hollow, occurred in the resistance curve for waves around about 190ft. in length, at both 8 and 10 knots speed of advance. That is to say, this depression is independent of the period of encounter, and of the natural pitching period of the boat, and it must therefore be governed by some other feature.

Again, the models in waves of about 250ft., at both 8 and 10 knots, experienced very large resistances, and it would appear that this increase was independent of the natural pitching period. In models with which this wave length approximately results in the period of encounter being equal to the natural pitching period, the increase of resistance is most marked, but for all models it is considerable. With model 487A at 8 knots, having a natural pitching period of 5·45 sec., the top of the hump coincides with a period of encounter nearer the natural pitching period, *i.e.*, occurs in waves 265ft. long. With this same model loaded so as to have a natural pitching period of 4·6 sec.—somewhat below the period of encounter in waves 250ft. long—the effect is more distributed—see Fig. 2.

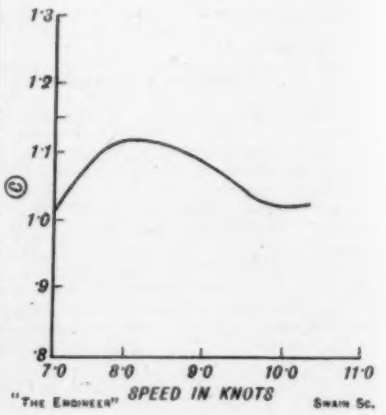
Following this hump, there is a marked hollow, occurring in most cases for waves of about 315ft. in length, but for some conditions of loading this hollow occurs later. On the whole it appears to be independent of both the period of encounter and the natural pitching period. In model 487A, for example, when so loaded as to have a natural pitching period of 5·45 sec. a very marked depression occurs when in waves of 310ft. length at 10 knots, despite the fact that the period of encounter then synchronises with the natural pitching period. The same is true for model 487B at 10 knots with a natural pitching period of 5·50 sec., with which the depression in the resistance curve occurs in waves 314ft. long, resulting in a period of encounter of 5·50 sec.

This depression is followed by another hump occurring generally in waves between 420ft. to 450ft. in length. In the models having a natural pitching period of about 7·0 sec., this hump is very marked, because it also coincides with a period of encounter of about 7·0 sec. In longer waves the resistance

TABLE I.—*Wave Length and Periods of Encounter at which Features Occur in the Resistance Curves.*

Model No. and speed.	Natural pitching period.		Features of resistance curve. Hump.	Hollow.	Hump.	Hollow.	Hump.	Hollow.
Model 487A. Speed 8 knots	7·1	Wave length in feet	160 (slight)	188	250	314	Rises to very large hump at natural pitching period	
		Period of encounter	3·80	4·21	5·07	5·86		
	5·45	Wave length in feet	160 (slight)	190	265	325	420	586
		Period of encounter	3·80	4·25	5·26	5·98	7·0	8·59
	4·6	Wave length in feet	160	190	266	372	425	574 flat hollow
		Period of encounter	3·80	4·25	5·28	6·50	7·05	8·45
Model 484. Speed 8 knots	7·1	Wave length in feet	162 (slight)	190	230	280	426, long flat hump	
		Period of encounter	3·83	4·25	4·80	5·45	7·07	
	6·1	Wave length in feet	162 (slight)	190 (slight)	240	304	372	Falls away contin'sly
		Period of encounter	3·83	4·25	4·93	5·73	6·50	
	5·0	Wave length in feet	—	170	240	390	462	584 flat hollow
		Period of encounter	—	3·94	4·93	6·70	7·42	8·55
Model 487A. Speed 10 knots	7·0	Wave length in feet	—	205	Flat 270–330, rising rapidly at 500 near the natural pitching period			
		Period of encounter	—	4·16				
	5·45	Wave length in feet	150	198	260	310	424	620 flat hollow
		Period of encounter	3·36	4·07	4·87	5·46	6·66	8·46
	4·5	Wave length in feet	—	185	260	366	455	Falls off to flat curve
		Period of encounter	—	3·87	4·87	6·07	6·97	—
Model 487B. Speed 10 knots	7·0	Wave length in feet	168 (slight)	195 (slight)	250	314	Rises rapidly at natural pitching period	
		Period of encounter	3·63	4·02	4·74	5·50		
	5·5	Wave length in feet	162 (slight)	196 (slight)	264	314	414	630 flat hollow
		Period of encounter	3·54	4·04	4·92	5·50	6·57	8·54
	4·5	Wave length in feet	150	195 (slight)	268	354	452	615
		Period of encounter	3·36	4·02	4·97	5·95	6·95	8·42
Model 484. Speed 10 knots	7·1	Wave length in feet	—	185 (slight)	234	318	492	670
		Period of encounter	—	3·87	4·66	5·55	7·32	8·88
	6·1	Wave length in feet	—	185 (slight)	234	318	442	598
		Period of encounter	—	3·87	4·66	5·55	6·85	8·27
	4·86	Wave length in feet	—	175 (slight)	230	350 flat hollow	442 flat hump	572
		Period of encounter	—	3·74	4·61	5·90	6·85	7·62

TABLE II.—*Features of Resistance Curves of Models at Varying Speeds in Waves of 400ft. Length.*

Model No. and natural pitching period.	Wave height in feet.		Features of resistance curve. Hump.	Hollow.	Hump.	Type of curve.
Model 484. Natural pitching period 6·1 sec.	6·0	Speed (in knots)	8·0	—	—	
		Corresponding period of encounter	6·80	—	—	
	4·5	Speed (in knots)	8·4	11·35	—	
		Corresponding period of encounter	6·73	6·21	—	
	3·0	Speed (in knots)	9·25 (flat hump)	11·90 (flat hollow)	—	
		Corresponding period of encounter	6·58	6·12	—	
Model 487A. Natural pitching period 5·45 sec.	6·0	Speed (in knots)	8·2	—	—	
		Corresponding period of encounter	6·76	—	—	
	4·5	Speed (in knots)	8·0	10·7	—	
		Corresponding period of encounter	6·80	6·31	—	
	3·0	Speed (in knots)	7·45	9·0	10·1	
		Corresponding period of encounter	6·92	6·62	6·41	
Model 487B. Natural pitching period 5·5 sec.	6·0	Speed (in knots)	7·25 (slight)	8·85 (slight)	9·2 (slight)	
		Corresponding period of encounter	6·97	6·66	6·60	
	4·5	Speed (in knots)	8·1	—	—	
		Corresponding period of encounter	6·78	—	—	
	3·0	Speed (in knots)	—	8·4	—	
		Corresponding period of encounter	—	6·73	—	

curve rapidly falls off, and for some of the models there is a slight hollow in waves of about 600ft. long.

Examining the other curves, details of which are given in Table II., only one prominent hump can be identified, and in almost every case it occurs at about 8·0 knots. This is, of course, for waves 400ft. long, so that the period of encounter is 6·80 sec. The hump therefore does not appear to bear any relation to the natural pitching period which varied in the three models tried from 5·45 sec. to 6·1 sec., although it does appear to be governed by some periodic effect. Referring back again to Table I., it would appear to arise from the same cause as the hump occurring in

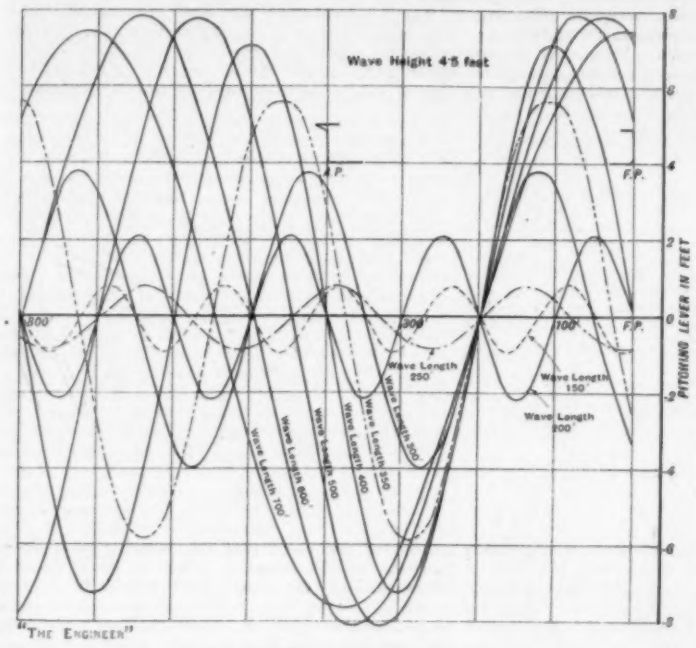


FIG. 3—CURVES OF PITCHING LEVER

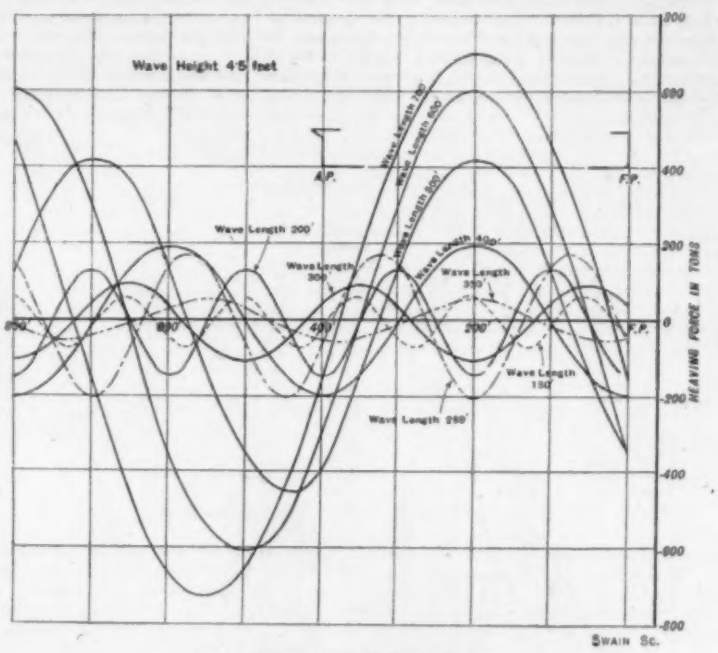


FIG. 4—CURVES OF HEAVING FORCE

there is, therefore, a maximum amplitude at about 200, and a minimum at about 250—and if the model pitching amplitude keeps phase with the amplitude of the pitching lever, and the resistance is greatly affected by the pitching, then, when in waves of 200ft. and 250ft. respectively the resistance should in the one case be large and in the other small. Experiment shows that the converse happens—*i.e.*, at 200 the resistance is small, whilst in waves of 250ft. length the resistance has increased enormously. Furthermore, the pitching lever amplitude increases rapidly as the wave length increases beyond 250ft., and were resistance influenced largely by this factor, no further depression would occur in the resistance curve, which would go on steadily increasing. Yet, as we know, at least two subsequent depressions do occur.

The "heaving" forces introduced are shown in Fig. 4, in which again the force at any point is the difference between the weight and buoyancy forces, when the wave crest is at the point in question. In order to illustrate more clearly how the "heaving" forces vary with wave length, Fig. 5 has been prepared. In it the "heaving" force when the wave is in some definite position with regard to the ship is plotted against wave length. From this diagram it is evident that the forces causing the ship to heave in and out

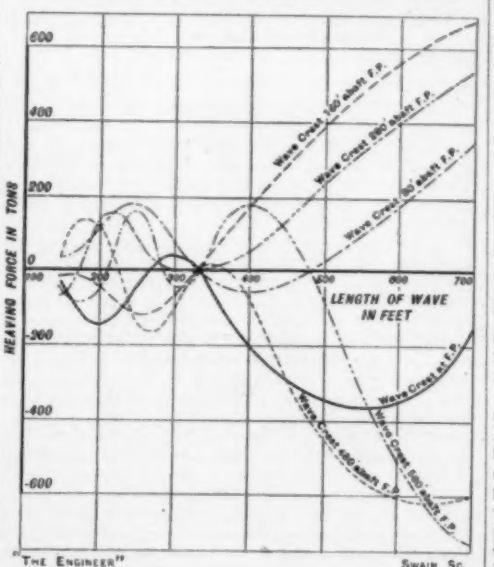

Wave Crest 160' abaft F.P.
Wave Crest 280' abaft F.P.
Wave Crest 80' abaft F.P.
Wave Crest at F.P.
Wave Crest 480' abaft F.P.
Wave Crest 640' abaft F.P.
LENGTH OF WAVE IN FEET
HEAVING FORCE IN TONS
"THE ENGINEER"
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FIG. 5—VARIATION IN HEAVING FORCE WITH WAVE LENGTH

of the waves are small in waves of 165ft. to 170ft., grow rapidly to a maximum in waves of about 240ft. and are almost negligible for waves of 330ft. length, from which point onward the heaving force grows continuously. This cycle of changes coincides approximately with the changes in resistance experienced, and it is not unreasonable to suppose they are instrumental in bringing them about. That is to say, the heaving in and out of a ship in waves very seriously affects the resistance, and it would appear to affect it far more than does the pitching.

But there is another reason why the resistance hump occurring in waves about 250ft. long is so very marked.

A vessel depressed deeper than its normal waterline into a fluid, and then released, will perform heaving oscillations, and the natural period of these oscillations is approximately given by

$$T = 2\pi\sqrt{\frac{\Delta}{g\rho A}}$$

where Δ is the displacement.
A is the waterplane area.
ρ the density.

The natural period for model 484 is, therefore, approximately 5.06 sec., and the periods of models 487A and B should be slightly longer than that for 484 on account of the finer water plane forward.

It is therefore evident for these models at 8 knots and 10 knots in waves 250ft. long, that the period of encounter, which is also the period of the fluctuations tending to produce a heaving motion in the model, synchronises approximately with the natural heaving period, and so the heaving under these conditions would be excessive. It should also be noted that the hump occurs a little earlier in model 484 than it does in models 487A and B, owing no doubt to the longer natural heaving period of these latter models.

We have therefore accounted for the following changes in the resistance:—The depressions occurring among waves of 190ft. and 320ft. respectively, which is due to the minimum of heaving going on among waves of that length, and the marked hump occurring among waves 250ft. long, when, besides a synchronism between the natural heaving period and the period of encounter, there is also a maximum of the forces tending to induce heaving.

The other feature of the curves is another marked increase in the resistance occurring in waves about 440ft. in length, followed by a depression when among waves about 600ft. in length.

From the curves of pitching angle it will be seen that the maximum angle of pitch grows rapidly as the wave length increases up to about waves of 450ft.–500ft., and then begins to fall off again just as rapidly. The curves of pitching lever for waves of these lengths all have large amplitudes, and the amplitude does not begin to fall off until in waves of 570ft., and it is not appreciably reduced even in waves of 700ft.

Similarly the "heaving forces" become large, and although no heaving records have been published, I think it can be assumed that the amplitude of heaving will tend to follow approximately the magnitude of the force up to, say, waves about 500ft. long. A feature that may be of importance is the phase in which the ship meets the wave; from the information published it would appear that over the range in which the resistance is excessive, the bow of the ship is rising through the approaching crest, and then descending into it as it passes, and that as the waves get longer it has begun to descend before the wave crest reaches the bow. Yet another fact, and probably one which has most to do with the fluctuation in the resistance, is that, with the increase of wave length, the period of encounter—*i.e.*, the time element—gets greater, and, furthermore, the wave slope gets much less. Moreover the waves are becoming appreciably longer than the boat, the boat may therefore adjust itself to the mean wave slope, moving up and down and pitching in phase with the passing wave, without experiencing a very great increase of resistance, because among these very long waves conditions are beginning to approximate to those of still water again. At some particular wave length there will be a conflict between the desire of the ship to ride over the waves, or to plough through them,

these experiments in wave lengths of 420ft. to 450ft. At 8 knots this occurs most in waves of 420ft., when the period of encounter is 7·0 sec., while at 10 knots it occurs most in waves of about 450ft. when the period of encounter is 6·93 sec.

We have therefore quite a number of very marked fluctuations in the resistance, as wave length increases, and only in a very few cases can these fluctuations be attributed to a synchronism between the natural pitching period and the period of encounter. Since also they occur with a regularity that is rather astonishing, considering the very varied conditions of loading—altering the natural pitching period from 4·5 sec. to 7·1 sec.—this regularity must be due to a feature or quality of the models, common to all the three forms, and it suggests that there is some geometrical reason underlying the phenomenon.

Consider a ship held in one place rigidly while waves pass by it, head on, and in a regular sequence. This ship will experience a force which, were she free to move, would cause her to rise and fall vertically, and she will also experience a moment tending to cause pitching. The first of these effects is due to the difference in weight and buoyancy, as the wave passes; sometimes the buoyancy forces are greater, and the vessel tends to rise, at other times the weight is in excess of the buoyancy and the vessel tends to sink deeper into the waves. The pitching moment depends on the distribution of buoyancy along the length; as the wave passes the ship, the centre of buoyancy moves first in one direction from the static position, then recovers, and moves in the opposite direction returning again and continuing this harmonic motion.

The "heaving" forces and the "pitching" levers for this one position are easily calculated for any instantaneous position of the wave relative to the ship, and although they are only true for that one position of the ship, yet they convey some idea of the disturbing forces brought into action as the ship moves forward among waves. The "heaving" forces and "pitching" levers have been calculated for model 484 in waves of 4·5ft. high, and of varying lengths from 150ft. to 700ft. The fore and aft distribution of area in the case of models 487A and B is so little different from that of 484, that the curves are approximately true for these models as well. Curves of pitching lever for 484 were given in Mr. Kent's paper. They were, however, drawn for the model in waves 6ft. high, and so differ slightly from those given in Fig. 3.

Considering first the pitching forces introduced—the pitching levers are shown in Fig. 3 for different positions of the wave relative to the ship, and the diagram shows the position of centre of buoyancy forward or aft of the "static position" when the wave crest is at the point being considered. It will be noticed that the amplitude of the pitching lever grows as the wave length increases from 150ft. to 200ft., and at 250ft. is quite small again, but from then onward it continues to increase very rapidly.

and when among waves of this length the resistance would be great. It would appear that this happens when the waves are just greater in length than the vessel, the actual length being partly dependent on the loading.

In the three models 484, 487A and B, when the loading was such as to give the ship a natural pitching period of 7·1 sec., this period synchronised with the period of encounter, and approximately with the "critical" wave length, and resulted in the resistance curve having an unusually large hump. For models with a natural pitching period of 5·5–6·1 sec. the hump occurred in slightly shorter waves—usually in waves about 50ft. shorter than when the natural period was 7·1 sec.—thus bringing the period of encounter, and the natural pitching period nearer to synchronism. But with the models loaded to have a pitching period of 4·5–5·0 sec., in general, the hump occurred among waves about 450ft. long, *i.e.*, when the period of encounter was about 6·90 sec., a period so different from the natural pitching period that it might be inferred that variations in the position of the hump from that wave length were mainly brought about by the manner in which the ship is loaded.

So little has been published about the variation of the resistance with speed, when among waves of constant length, that it is next to impossible to make any useful analysis of the results summarised in Table II., and, therefore, until more data are available I think it best not to deal with that question.

From the foregoing, it is evident that the "heaving" is of as much importance as the "pitching," and the natural heaving period should be considered along with the natural pitching period, when either is counted important enough to be taken account of during the design stage of a boat.

The pitching is governed largely by the loading, which is more or less in the hands of the captain, though it is dependent upon the longitudinal moment of inertia of the waterplane area. The heaving is dependent upon the waterplane area and the displacement, and within limits can be varied quite a considerable amount. The models in the set of experiments under discussion were only run at one displacement, and, unfortunately, the natural heaving period and the maximum heaving force came approximately into synchronism with the period of encounter. Had the models been loaded more deeply, very little change would have taken place in the waterplane area, and the longer natural pitching period bringing the synchronism between it and the period of encounter nearer to where the heaving forces are small, may have resulted in the resistance fluctuations being much smaller.

Passing, however, from a consideration of model results to the actual experience of ships at sea, it should be possible to find evidence of fluctuations of resistance, which should show either as a fluctuation in the shaft horse-power or a reduction of the speed, similar to the fluctuations experienced by the models and attributable to the same causes. Very few completely reliable, and at the same time sufficiently comprehensive, sets of ship data are available. The data collected by Mr. Kent are perhaps the most satisfactory for the purpose of the present analysis, and the results for the San Gerardo, given in his paper "The Effect of Wind and Waves on the Propulsion of Ships," have been selected for consideration. Table III. gives some of the results selected because the waves are more or less "head on" and 5ft. in height—all the data collected have been included in order to gauge the relative importance of the factors affecting the propulsion. (Note.—All the data connected with each observation were unfortunately never published; Table III. is therefore unavoidably incomplete.)

The San Gerardo is a vessel built for carrying oil in bulk. Its principal dimensions are:—Length between perpendiculars, 530ft.; breadth, 68ft. 6in.; draught, mean, 30ft. 9in.; displacement, 25,700 tons.

The natural pitching period is given as 10·2 sec., and assuming a likely coefficient for the waterplane area, the natural heaving period is about 5·85 sec.

TABLE III.—*Observations Taken at Sea on the San Gerardo.*

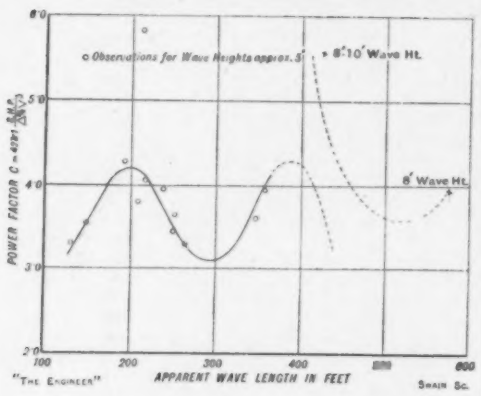
Observation number.	Speed of ship in knots.	Revs. per min.	S.H.P.	Wind relative to ship.		Wave.				Pitching.		Rolling.		Rudder angle and direction.	Power factor C = 427·1 S.H.P. / $\Delta^{\frac{2}{3}} V^3$.
				Speed in knots.	Direction.	Length in feet.	Height in feet.	Direction.	Period of enc't'r, sec.	Period, sec.	Max. angle in deg.	Period, sec.	Max. angle in sec.		
9	7·33	56·5	2665	20·8	30° P. bow	1050	5–6	Head on	11·3	9·0–9·7	3·3	10·3	11·3	0–8° S.	4·56
11	7·57	55·4	2540	18·2	45° P. bow	353	5	10° S. bow	7·5	9·3	2·7	11·4	7·1	5° P.–5° S.	3·95
20	7·24	55·1	2600	34·7	30° S. bow	297	5–6	30–45° S. bow	6·1	10·0	2·7	10·6	8·9	5° P.–7° S.	4·70
22	6·75	55·8	2608	36·9	10° S. bow	213	5–6	5° S. bow	4·8	10·5	2·8	11·3	8·9	6° S.–16° S.	5·82.
23	8·09	—	—	26·0	45° S. bow	261	5–6	10° S. bow	(5·2)	—	—	—	—	6° P.–12° S.	3·28
24	8·18	—	—	39·1	5° P. bow	131	3–4	Head on	3·3	10·3	2·3	9·8	8·0	6° P.–12° S.	3·285
26	7·62	55·5	2535	39·1	10° P. bow	240	5–6	Head on	(5·0)	—	—	—	—	6° P.–27° S.	3·95
28	7·97	56·8	2630	19·5	20° P. bow	348	5	Head on	6·25	9·8	3·4	10·0	7·1	0–12° S.	3·58
29	8·05	56·1	2572	17·8	10° P. bow	253	5	Head on	5·1	9·7–10·4	3·2	10·6	6·6	12° P.–14° S.	3·41
36	8·07	—	—	43·6	Head on	149	5–6	Head on	3·95	9·2–10·0	3·1	10·7	13·2	5° P.–12° S.	3·515
37	7·63	—	—	46·6	5° P. bow	193	5–7	Head on	4·35	9·1–9·9	2·9	10·1	8·9	6° P.–6° S.	4·27
38	7·70	—	—	39·1	Head on	218	4–5	Head on	4·7	9·9	2·9	10·6	9·8	11° P.–15° S.	4·05
39	7·88	—	—	34·7	Head on	206	4–5	Head on	4·5	10·1	3·5	10·2	16·5	7° P.–15° S.	3·794
40	8·00	—	—	39·1	Head on	252	5	5° S. bow	5·1	9·6	2·4	9·8	12·3	9° P.–10° S.	3·625

If the fore and aft distribution of the displacement for the San Gerardo is assumed to be similar to that of model 484, then heaving forces and pitching levers of Figs. 3 and 4 may be taken to represent those for the San Gerardo, when the wave lengths have been increased in the ratio of the linear dimensions—530 : 400. The natural heaving period is given by—

$$T = 2\pi\sqrt{\frac{\Delta}{g\rho A}}$$

and will only be increased in the ratio of the square root of the linear dimensions.

There are two possibilities to explore. The first is whether the heaving forces and pitching lever variations are sufficient, apart from any synchronism that may occur, to produce fluctuations in the resistance? The second possibility is that the fluctuations introduced are caused by the heaving or pitching periods synchronising with the period of encounter. The first of these considerations depends only on the geometric qualities of the ship, and from the preceding analysis we may say that the heaving forces on the ship are likely to be a maximum in waves of 320ft. and a minimum in waves of 440ft.


Observations for Wave Heights approx. 5'
8'10' Wave Ht.
6' Wave Ht.
POWER FACTOR C = 427·1 S.H.P. / Δ^⅔ V³
APPARENT WAVE LENGTH IN FEET
"THE ENGINEER"
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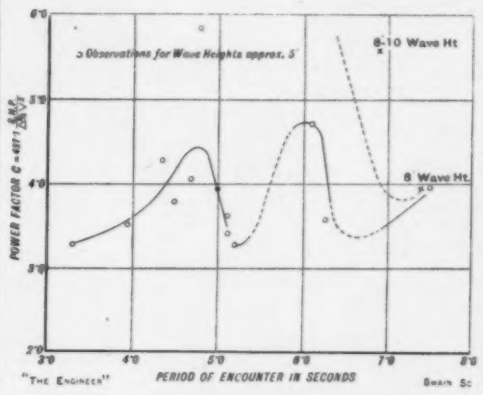

Observations for Wave Heights approx. 5'
8-10 Wave Ht
8 Wave Ht.
POWER FACTOR C = 427·1 S.H.P. / Δ^⅔ V³
PERIOD OF ENCOUNTER IN SECONDS
"THE ENGINEER"
SWAIN Sc

FIG. 7

Ships at sea very seldom meet waves "head on," and so in making the analysis wave lengths projected along the vessel's length have been employed. Again, the ship's speed, displacement, revolutions of propeller and the consequent power are continually varying, and to take account of this variation the power constant—

$$C = \frac{427 \cdot 1\ \text{S.H.P.}}{\Delta^{\frac{2}{3}} V^3}$$

has been adopted. Fig. 6 shows the values given in Table III. for this power constant C, plotted to a base of "apparent" wave length; an approximate curve has been made to pass through the spots.

The second consideration, that of synchronism, will be governed by the period of encounter, and Fig. 7 shows the power constant C plotted to a base of period of encounter.

The analysis, as far as it goes, supports the previous investigation. There is evidence of an increase in the resistance when in waves of about 350ft., and a minimum of resistance in waves about 450ft. long. There is a rather well-defined hump for wave lengths of about 200ft. This hump would correspond to the one occurring in waves of about 160ft. for the shorter vessel, and this hump is rather well defined in the case of model 487A at 8 knots—see Fig. 2. The actual cause of the increased resistance is obscure. It appears to be independent of the loading, since it occurs always for the same wave length in the three conditions of loading of model 487A at 8 knots. Furthermore, the period of encounter does not bear any relation to the natural heaving period, and neither the pitching levers nor the heaving forces are very great for this wave length.

Fig. 7, which gives the same observations plotted to a base of period of encounter, does not, of course—owing to speed and direction differences—give the spots in the same relative order to those plotted in Fig. 6. Increased resistance due to synchronism of the period of encounter and the heaving and pitching periods should occur at 5·85 sec. and 10·2 sec. respectively, and there is evidence of increased resistance when the period of encounter is about 6 sec., that is, when it synchronises with the natural heaving period. There is also scanty evidence of another hump occurring at 10 sec., but this pitching period is so large that a vessel doing 8 knots would seldom encounter waves sufficiently long to synchronise with it.

It is not to be expected that observations taken at sea will result in such well-defined curves as those derived from model experiments in a tank; nevertheless, it is thought by the writer that the analysis reveals forces corresponding to the heaving and pitching forces that frequently doubled the resistance of the models, and it is hoped the present investigation will be of more than theoretical interest to those whose business it is to procure efficiency in ships.

The High-speed Cold Rolling Mill.

(*Contributed.*)

THE rolling speeds generally adopted in this country and on the Continent for cold rolling strip in both steel and non-ferrous metals, are very slow if compared with the speeds quite usual in hot rolling work, and until a few years ago, brass strip was rarely rolled at speeds exceeding 50 f.p.m.; even to-day a great number of mills are working at this low speed. In the production of cold rolled steel strip somewhat higher speeds are quite usual; generally about 70 to 80 f.p.m. During recent years there has been a gradual but steady increase in rolling speeds, and to-day it is the regular British practice to run strip finishing mills, for brass and other non-ferrous metals, at 80 to 90 f.p.m., and for steel strip about 100 f.p.m.

A good deal has been written comparing the rolling speeds adopted in the United States with those in this country, and it is very generally known in the trades concerned that speeds of 200 f.p.m. and even 250 f.p.m. are in accordance with regular American practice; in spite of this fact, British mill engineers and managers have not favoured working at such speeds, and where mills have been installed in one or two cases, to operate at speeds of 150 to 200 f.p.m., they have very often been altered after trials to reduced speeds of 90 to 100 f.p.m. Many different reasons have been put forward to explain this preference for slower speeds. The following are most usual:—

(1) Metal rolled at high speed is inferior in regard to accuracy and finish to that produced at lower speed.

(2) Increased speed necessitates lighter reductions or "pinches," and consequently a greater number of passes for any total reduction.

(3) Metal offers greater resistance to deformation at high speeds, and consequently a high rolling speed means increased consumption of power per ton rolled.

(4) It is difficult to handle metal delivered at speeds much over 100 f.p.m.

So far as the writer has been able to learn none

of the above objections are really founded on fact, and from tests carried out, both on experimental plant and on mills operating under workshop conditions, the following conclusions have been reached regarding the criticisms detailed above :—

(1) Accuracy and finish. With a mill properly designed to give sufficient rigidity and to eliminate excessive vibration at high speed, metal rolled at speeds up to 200 f.p.m. can be produced quite as accurately and as well finished as the same metal rolled at speeds from 50 to 100 f.p.m. It is possible that for extreme limits of accuracy when rolling very thin strip—·010in. thick and thinner—a moderate speed is preferable, although that is by no means proved, and, as will be shown later, loss of accuracy when rolling at high speed is not due to any inherent trouble with high roll speeds, but to secondary mechanical troubles which can be eliminated in a properly designed high-speed mills.

(2) Here, again, as regards the reductions per pass, there is no difficulty in obtaining reductions at high speeds equal to those usually taken at ordinary low speeds, providing sufficient power is available and the mill is heavy enough for the work.

(3) The theory that metal will not "flow" so easily under pressure at high speeds, and that consequently power consumption is increased cannot be confirmed by any reliable test results. Comparisons between mills of different sizes and types on work not exactly similar are most misleading, and all careful comparative trials have shown that the power absorbed by a cold rolling mill is nearly exactly in proportion to the rolling speed, between limits of 50 f.p.m. and 200 f.p.m. That is to say, the power absorbed per ton rolled on any specific reduction is the same at the higher or lower speeds.

An explanation of the very widely held opposite opinion is that, while the actual work in deforming the metal per ton rolled is the same for all speeds within the range under consideration, unless the roll bearings are properly designed and lubricated for high speed working, a rapid increase in frictional losses, with consequent excessive heating of bearings, will result in an excessive total specific power consumption. This most important point in high speed mill design will be considered further.

As will be understood by all engineers, with the heavy bearing pressures unavoidable in cold-rolling mills, an increase in speed may easily cause rapid generation of heat owing to bearing friction, and a cumulative increase in power consumption ; on the other hand, it is quite usual to find slow speed mills, not of the best type and in which the roll bearings are not in good condition, absorbing a considerably greater power per ton on metal rolled than is taken by a well designed high-speed mill.

(4) The last point considered, namely, the difficulty of handling strips when delivered from the rolls at 200 f.p.m. and similar speed, has some foundation.

It must be admitted that with hand feed to coiler, even at speeds of about 100 f.p.m., the operator is kept busy, and some skill and practice is necessary. However, with modern automatic coiling equipment, all necessity of handling the metal between the rolls and the coiler is avoided.

While, as explained above, the usual objections to higher rolling speeds cannot be said to be justified, there are very real difficulties in the way of high-speed work, the nature of which has been already indicated in the foregoing. They may be summed up as follows :

(A) The difficulty of maintaining a moderate temperature in the roll bearings.

(B) The necessity for more powerful mills and larger motors for any given work.

(C) With the rapid delivery of finished coils more assistant labour per mill is necessary.

The first-named difficulty is without doubt the greatest obstacle in the way of the general adoption of higher rolling speed. Even at moderate speeds of 50 to 80 f.p.m. with the heavy bearing pressures necessary to effect the reduction per pass required, the frictional losses in the roll bearings are considerable, with consequent rapid generation of heat ; and with mills of the ordinary type, without special provision for minimising friction, dissipating heat, &c., any increase in speed will inevitably result in an excessive temperature rise, the heat being generated at a greater rate than can be carried away by water cooling or other means, with the secondary result that the power taken by the mill is increased beyond reasonable limits. As previously mentioned, the excessive power consumption caused by inefficient roll bearings at high rolling speeds has given rise to the belief that high speeds are uneconomical owing to the greater cost of power per ton of metal rolled. Actually, with mills correctly proportioned for high-speed work, and a proper design of roll bearings, frictional losses can be reduced to within reasonable limits, and the power consumption remains strictly in proportion to the speed, being consequently in proportion to the output of rolled metal.

Similarly, the two remaining difficulties (B) and (C) are mainly a question of design both of the mill and its auxiliary coiling equipment, but the fact remains that for any given reduction or series of reductions the first cost of a properly equipped high-speed mill is necessarily greater than that of a mill for lower speed working and the labour cost per mill is somewhat higher.

With regard to this last point, it may be explained that a slow-speed mill working at, say, 60 f.p.m., can be worked comfortably by one roller and an assistant. With such a mill finished coils would be delivered at a rate not exceeding one every two or three minutes, while with the high-speed mill at 200 f.p.m. similar coils are completed at the rate of two per minute, with the result that the roller and his assistant are kept busy in feeding the mill and removing the finished coils, and to take full advantage of the high speed and to avoid loss of time between passes it is probably desirable to have a third assistant to ensure the regular and rapid supply of material to the mill and the removal of rolled metal. Even then, while the labour cost might be taken as 3 : 2 with the high-speed mill, the output is at least 3 : 1, and the labour cost per ton is approximately 50 per cent. of that with the slower-speed rolls.

Given a well-designed mill having sufficient power to utilise fully its capacity for a large output and proper organisation to ensure the supply and removal of material, the economy to be obtained by increasing rolling speeds to 180 or 200 f.p.m. is sufficiently obvious to require little further explanation.

Before considering this question more fully it will be of interest to describe here an example of modern high-speed mill practice.

The mill illustrated by Fig. 1 was recently built by W. H. A. Robertson and Co., Ltd., of Bedford, and erected in the works of one of the largest brass rolling firms on the Continent. It is interesting for two reasons : first, as being, as far as the writer is aware, the first and only high-speed brass strip rolling

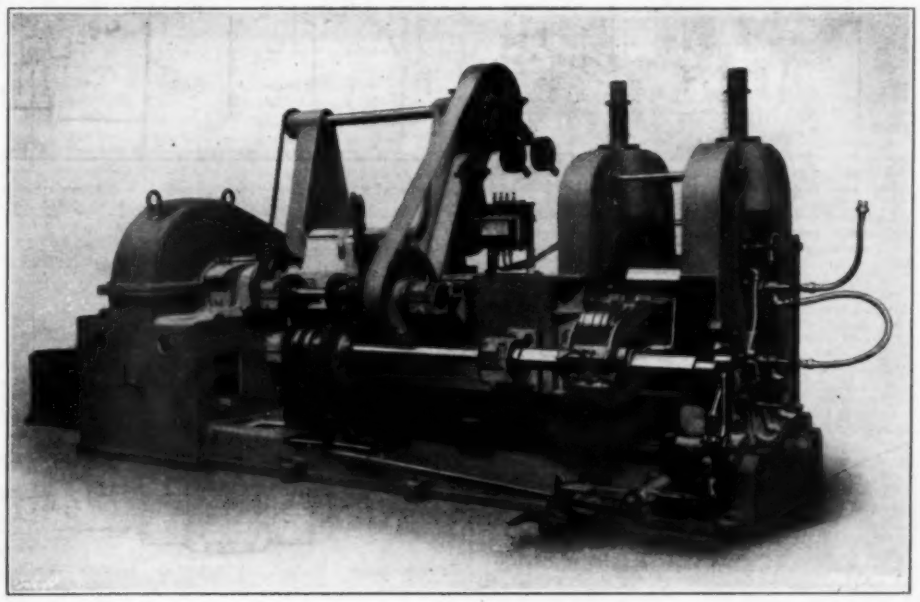


FIG. 1—HIGH-SPEED STRIP-ROLLING MILL

mill in Europe ; and secondly, that no mill of equal capacity has as yet been installed in this country. As mentioned previously, mills of this type and working at the same high rolling speed are the general rule in the United States, but this particular mill is especially remarkable in that it embodies many of the most advantageous features in British, American and continental mill construction. It has rolls 300 mm. diameter (11·8in.), 350 mm. face (13·8in.), and at a roll speed of 60 revolutions per minute has a rolling speed of 56½ metres per minute (185ft. per minute). But the actual roll speed is 62 revolutions per minute, and the rolling speed is consequently 58·5 m. per minute, or 192ft. per minute. The nominal power of the driving motor is 80 horse-power at a speed of 600 revolutions per minute. The mill was guaranteed to effect certain definite reductions which were specified by the purchasing company, and was designed to reduce brass strips 160 mm. wide (6·3in.) from 1·5 mm. (·059in.) to 0·8 mm. (·0315in.) in two passes. The first pass after annealing to be 1·5 mm. to 1·05 mm. (·059in. to ·041in.), equivalent to a 30 per cent. reduction in thickness, and the second pass 1·05 mm. to 0·8 mm. (·041in. to ·0315in.), equivalent to a reduction of 23·8 per cent. Actual trials proved the mill to be capable of heavier reductions on a greater width of metal than that specified.

Dealing with the mechanical features in detail, the rolls are of forged chrome alloy steel, hardened to 95 deg. to 100 deg., as measured by Shore's scleroscope, accurately finished by grinding, the barrel being finished to a camber, that is to say, having a slightly larger diameter at its centre than at the ends. The roll frames or housings are especially heavy to avoid all possibility of spring or excessive vibration and are fitted with special phosphor-bronze roll bearings lined with anti-friction metal and provided with internal channels for cold water circulation, by which the "brasses" themselves are cooled. Besides this, the usual connections for water circulation to the interior of the rolls are fitted. The flexible water pipe connections to both rolls and bearings are seen at the right-hand end of the illustration. To ensure adequate and continuous lubrication to the roll bearings, a special system of forced oil feed is provided, a separate oil pipe being led directly to each bearing from a central reservoir and sight-feed lubricator with oil pump, shown mounted in the centre of the mill just beyond the left-hand housing, the oil pump being driven by a small crank on the overhead shaft.

The top roll is adjusted in the usual manner by fine-pitch forged steel screws, working in steel nuts secured in the central boss of each roll housing. The rolls are driven in the ordinary way from the pinions by means of steel coupling spindles and coupling sleeves, which are accurately machined to give just sufficient clearance to permit the necessary vertical adjustment to the top roll. (These spindles are hidden by the bracket supporting the coiler gear in the illustration.) The pinions are of forged steel, have double helical machine cut teeth, and are mounted in a totally enclosed gear case or pinion housing, providing an oil bath for the gears, with independent automatic lubrication to the pinion bearings.

The driving motor, not shown in the illustration, is mounted on a bed-plate, just seen at the left-hand end of the mill. The motor is connected through a flexible coupling to the gear shaft, which is forged of high carbon steel in one piece with the pinion, which gears with a spur wheel, both being contained in a totally enclosed gear-box. This pair of gears reduces the speed from about 600 to 60 revolutions per minute, and has machine cut double helical teeth. The shaft bearings are of the ring-oiled type, and the slow speed shaft is coupled to the lower mill pinion spindles through a special steel coupling. The whole mill forms an entirely self contained machine, the main bed-plate, gear-box and motor bed being all rigidly bolted together.

In order to handle the strip as it issues from the rolls at this high speed, special coiling equipment is fitted. It was built to designs furnished by the Torrington Manufacturing Company, of Torrington, Connecticut, U.S.A., with whom the Bedford firm is closely associated. This automatic coiler is clearly shown in Fig. 1, which gives the coiler side of the mill, and its main features are the provision of great power, insuring sufficient tension on the strip between the rolls and the coiler driver ; automatic guiding and feeding of the metal from rolls to coiler, adjustable friction device to regulate the tension, and provision for reversal of the coiling spindle to loosen the coil to facilitate removal of coiled metal. Coilers of this and even more elaborate types are fitted to nearly all the brass strip mills in the United States, and already several have been fitted to mills in this country.

Generally the mechanism of the coiler is simple ; by means of a chain drive from main gear shaft to the overhead shaft, the coiler first motion shaft is driven by a heavy belt running on flanged pulleys and provided with a belt tightening device. The driven pulley contains a multiple-plate friction clutch, which provides both for the necessary slip to compensate for the increasing speed due to the growing diameter of the coil, and for the regulation of the tension on the strip. It is possible to apply such a tension to a strip that the metal is torn apart. Between this maximum tension and the lightest pull, fine adjustment is obtained by means of the hand lever and notched quadrant seen just to the left of the clutch pulley. The shaft carrying the pulley is geared through machine-cut spur wheels to the main coiling shaft, the double set of gears being required in order to provide for reversal of the wind, and a double jaw clutch of special design is fitted and operated by foot

pedals, placed conveniently for the operator. By means of these pedals the coiling shaft can be stopped and started in either direction at will; at the same time a system of links interlocked with the clutch pedal swing clear the outer supporting bearing of the coil spindle—seen at the right-hand end of illustration—when the spindle is stopped, thereby allowing free removal of the finished coil. The coiler drum itself is fitted on the square portion of the coiler spindle and is removed with the finished coil, and a spare drum is immediately slipped on, in its place, so that rolling can be continued almost without a break. The finished coil can be removed from the first drum while the second coil is being wound.

The essential feature of this coiling equipment is the automatic guide, shown encircling the coiler drum immediately behind the rolls, but too much space would be required to describe this most ingenious device in detail; it is sufficient to explain that by its aid the strip issuing from the rolls is guided round the drum and securely tightened on it, without need for any handling by the operator, who is only required to stop, start, or reverse the coiler and to assist in removal of finished coils as they are formed. The whole coiling equipment is mounted on a cast iron bracket or base, bolted to the roll housing and pinion housing.

In operating a mill of this type a short test piece of strip is rolled to obtain the correct setting of the rolls for the required reduction. The coils are then passed through the mill continuously, the roller at the feed side of the mill inserting the leading end of the strip, passing it through the guide, and screwing down the cleaning press, which is provided on the guide table, immediately the metal is gripped by the rolls. His assistant at the coiler sees that the coiler drum is in position, the automatic guide closed and the coiling spindle started in the right direction. The metal passes automatically from the mill rolls, is led by the guides round the drum, on which, after the first two or three turns, it is firmly gripped and exerts a powerful tension on the strip, thereby removing any buckles or waves. As the coil is wound on the drum, which consequently grows in diameter, the speed of the drum is automatically reduced by the slipping of the friction clutch previously mentioned, and a uniform tension is maintained. At the same time the automatic guide opens out to accommodate the increasing coil diameter. Immediately the rear end of the strip leaves the roll, and is wound on the drum, the man at the coil stops the spindle by means of the foot pedal provided, the guide in the meantime preventing the loose end from flying free and causing damage. With the drum stopped, he opens the guide, depresses the reversing pedal which immediately loosens the coil on the drum; the reverse stopping immediately the operator's foot is removed from the pedal. By the interlocking gear, the outer end bearing of the coiler spindle has swung clear, and the man has only to slide the drum with the coil off the spindle, replacing it immediately by an empty drum, and the cycle recommences.

As the operations described only occupy a few seconds, and as meanwhile the roller has the second coil ready to insert in the rolls, the operation of rolling is practically continuous. Indeed, the mill rolls are not stopped but run continually, but by means of a push button switch placed conveniently to the roller, the motor may be stopped instantly in case of accident.

A third assistant is required to handle the finished coils, which are delivered to him as described above, and has only to remove the drum, and place it in readiness to replace the next finished coil.

Fig. 2 shows the general arrangement of the mill, described above; it will be noticed that the adjustment of the top roll is obtained by screws operated by spanners, as this method is most popular in this country and in America for finishing mills; but as continental rollers generally prefer a geared roll adjustment with a hand wheel operating both screws simultaneously, this gearing may be provided.

On actual test this mill was found to be capable of heavier reductions than those specified, and Table I. gives details of reductions actually accomplished. To compare the output possible from a mill of this type with that from an ordinary slow speed mill, the time actually occupied in rolling a 50 lb. coil of strip. 6¼ wide, ·060in. thick to ·040in. thick, in one pass, in a high-speed mill with a rolling speed of 180 f.p.m. is about 18 seconds—the length of finished coil being about 54ft.—that is to say, it is theoretically possible to roll three and one-third coils per minute, or 10,000 lb. per hour. The factor of rolling efficiency has to be taken into account before the actual rate of production can be estimated.

Rolling efficiency is the ratio of the time which a mill is actually rolling metal to the total working time. American mills claim to work at an average efficiency of from 75 per cent. to 80 per cent., but taking a more conservative figure of 50 per cent., the actual production in the example taken would be 5000 lb. per hour, or, say, 45 cwt.

In the case of the ordinary slow-speed mill working at about 60 f.p.m. the net time rolling one coil will be 54 seconds, giving a theoretical output of 1·1 coils per minute or 3300 lb. per hour. The rolling efficiency of a mill of this type would no doubt be less than that of a high-speed mill, but taking the same figure of 50 per cent. there would be an output of 1650 lb. per hour, or, say, 14½ cwt. per hour.

Assuming that three men are necessary to operate the high-speed mill and two men the low-speed mill, we have an output of about ·75 tons per hour per man, in the former case and about ·37 tons per hour per man in the latter.

These results are summarised in detail in Table II. It may be contended that such outputs, although shown to be possible, cannot be maintained in practice; in which case the rolling efficiency must be lower than that assumed; and the production for both high and low-speed mills must be reduced in proportion, but in any case for the purpose of comparison the figures given are sufficiently correct.

It is quite understood that in both cases a proper system for the transport of material to and from the mill must be provided, otherwise a considerably greater margin of lost time between passes must be allowed.

From the foregoing it will be obvious that one high-speed mill with three men and an average power demand of 65 horse-power would produce the same quantity of metal as three slow-speed mills employing six men, with an average power consumption of 21 horse-power each. In comparing the output per man as above the figures do not really represent the actual wages cost per ton, as only one man in each case is paid full rollers' wages, and the extra labour recommended for the high-speed mill is only that of an unskilled man or lad, who is required merely to remove finished metal and to supply the unrolled metal to the roller.

It may also be pointed out that a slow-speed mill can be worked by one man only, the roller feeding the metal, attending to the coiler and also handling his own metal supplies and finished material; but this can obviously only be done at the expense of rolling efficiency, and in the same way a high-speed mill can be worked by two men only, with a somewhat smaller loss of efficiency; in the figures given above two and three operators, for the low and high-speed mills respectively, have been assumed, as this *personnel* is necessary if the maximum output is to

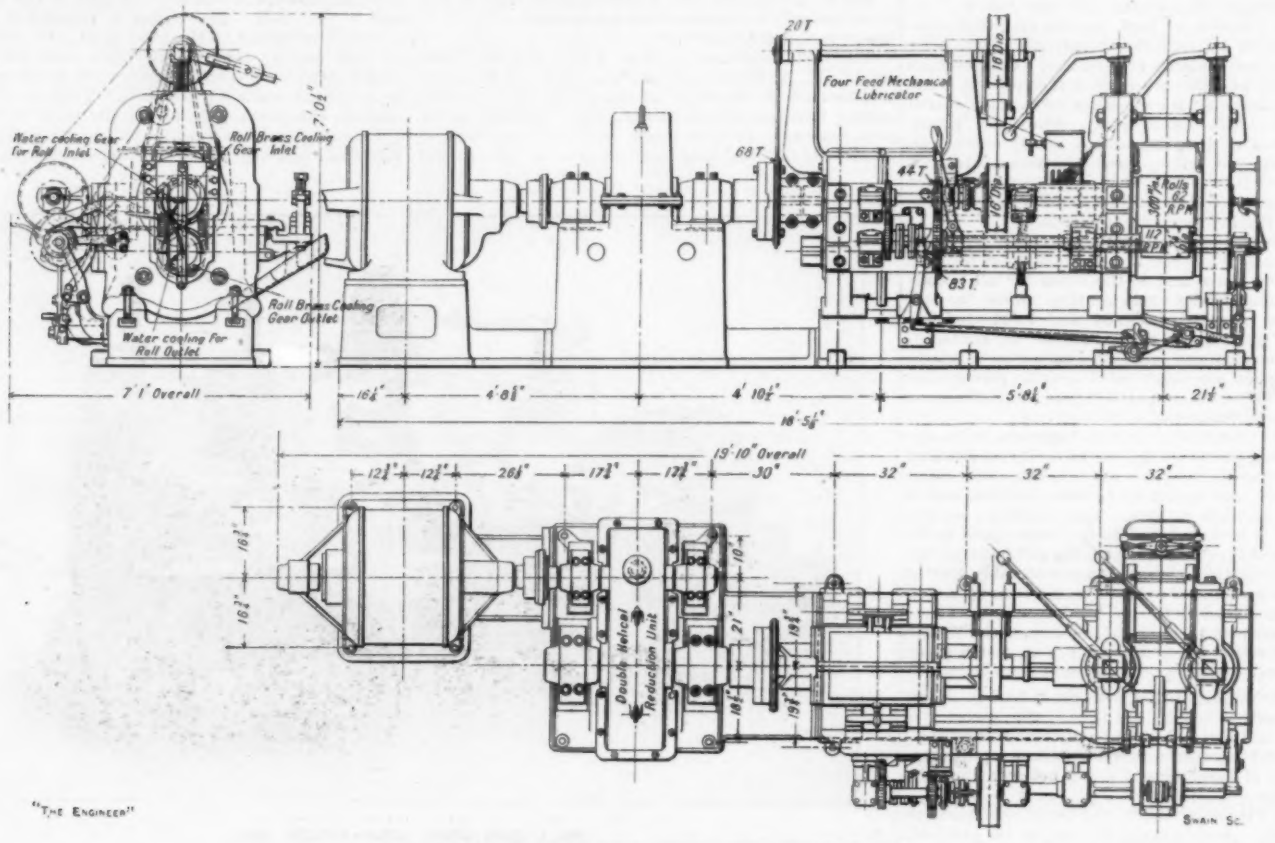


FIG. 2—ARRANGEMENT OF HIGH-SPEED STRIP-ROLLING MILL

TABLE I.—*Reductions Obtained in High-speed Rolling Mill. Rolls, 300 mm. diameter; Rolling Speed, 192ft. per minute; Material Rolled, Brass Strip.*

Width.	Thickness before rolling.	Thickness after rolling.	Reduction.	Per cent. reduction.	Remarks.
mm.	mm.	mm.	mm.		
200	1·5	1·1	·4	26·5	1st pass
170	·8	·7	·1	12·5	2nd pass
170	·7	·5	·2	28·5	2nd pass
180	·85	·6	·25	29·5	2nd pass
180	1·5	·8	·7	46·5	1st pass
175	1·5	1·0	·5	33·3	1st pass
175	1·0	·8	·2	20·0	2nd pass

NOTE.—The remarks in last column give the number of pass after annealing.

TABLE II.—*Comparative Outputs from High and Low-speed Mills. Rolling Annealed Brass Strip 6¼in. wide, ·06in. thick to ·04in. thick in One Pass. Weight of Coil, 50 lb.*

	High-speed mill. Rolling speed, 180 f.p.m. Rolling efficiency, 50%, one roller and two assistants	Low-speed mill. Rolling speed, 60 f.p.m. Rolling efficiency, 50%, one roller and one assistant.
Length of coil, ·04in. thick	54ft.	54ft.
Time rolling one coil ..	18 sec.	54 sec.
Time lost per pass	18 sec.	54 sec.
Total time per coil	36 sec.	108 sec.
Actual number of coils rolled per hour	100 coils	33 coils
Weight rolled per hour ..	5000 lb.	1650 lb.
Weight rolled per man per hour	1660 lb.	825 lb.
H.P. to drive mill, average	65 H.P.	21 H.P.

be obtained in either case. It is obviously uneconomical to employ an experienced roller on merely labourers' work in handling the material.

With regard to the power consumption, in both cases the minimum average power has been taken, assuming that in both mills the bearings are properly lubricated and efficient cooling is obtained. The power costs per ton are consequently the same in both cases.

In this connection it is of interest to call attention to the fact that since the high-speed mill described in this article was designed, rapid progress has been made by the makers in the application of roller bearings to all classes of strip-finishing mills, many such mills have been put to work, and a saving of from 30 per cent. to 50 per cent. in power consumption has been obtained.

This proportional saving is, of course, obtained both with high and low-rolling speeds, but owing to the greater power consumption per mill in the case of the high-speed mill the saving is of greater importance. (With the example of low-speed rolling considered the saving in power by the adoption of roller bearings would be from 7 to 10 horse-power, while with the high speed this saving would be from 20 to 30 horse-power.)

Furthermore, the rated power of the motor installed for driving the high-speed mill can certainly be reduced from 80 to 60 horse-power, thereby obtaining a considerable reduction in the first cost of the complete installation. More important, however, than the saving in motor power is the complete elimination of hot roll bearings, the risk of which is a serious cause of anxiety to all rolling mill managers and engineers, and, as will be understood from the foregoing, the importance of maintaining cool bearings, and consequently minimising bearing frictions, is of paramount importance in the case of the high-speed mill.

The writer is of the opinion that, now that the application of roller bearings has been proved to be successful with the cold rolling mill, the greatest obstacle in the way of the adoption of high-rolling speeds in this country has been removed.

Institution of Mechanical Engineers.

THE annual dinner of the North-Western Branch of the Institution of Mechanical Engineers was held on Thursday, 17th inst., at the Engineers' Club, Manchester, under the chairmanship of Professor Gerald Stoney, D.Sc., F.R.S. Although the gathering was not quite as large as that at the previous dinner, it was unanimously agreed that the evening was a great success. The toast list was commendably short. "The Institution of Mechanical Engineers" was proposed by Lieut.-Colonel Sir Joseph Nall, D.S.O., President of the Institute of Transport, who said that there was still room for improvement in steam engineering. It was obvious that we had not come to the end of this form of power and should have regard to its possibilities in considering the developments of other forms. The steam locomotive of to-day was, he said, substantially similar to that of Stephenson's period, and showed little improvement as regarded its thermal efficiency, and he urged the necessity of maintaining a true perspective. The public should not be coerced into believing that vast grants of State subsidies to one kind of power or a complete system of State control applied to that power was going to be to the benefit of the community as a whole.

In replying to the toast, Mr. Daniel Adamson said that the Government was relying on the assistance of institutions such as their own. The Institution of Mechanical Engineers was being consulted by the Government as to changes with regard to Whitworth scholarships and the training of aircraft apprentices. The proposal to disrate the engineers in the Navy was a matter for regret, and he trusted that if that proposal came before Parliament it would be seen that justice was done to that class of men. It was suggested that the executive curl should be removed from the engineer officers' cuffs, which meant depriving them of authority. The seriousness of such a proposal was obvious from the fact that 40 per cent. of the crew of a ship were concerned with engineering. Such a proposal would have the effect of deterring the right class of men from joining the Navy.

The toast "Our Guests" was proposed by Professor Watkinson, who referred to Sir Joseph Nall's remarks on the steam locomotive, which, he said, was an inefficient machine. Now that the railways had amalgamated it was hoped that money would be set aside for research into possible economies of power. He compared the railway locomotive with the prime movers used in road transport. For road purposes they were making use of fuel which cost twenty times as much as coal and were competing successfully. He said that heavy oil engines could be developed to serve the purposes of railway transport. Oil fuel could be used with a saving of labour and the efficiency would be at least five times as great as that of our present steam locomotives. We were, he continued, only at the beginning of the development of heavy oil engines. Mr. E. C. R. Marks responded to this toast.

Brigadier-General Magnus Mowat, C.B.E., secretary of the Institution, proposed the toast of "The Chairman," and referred in complimentary terms to the chairman's work in connection with the steam turbine and especially the research work on steam nozzles. He said that although neither the Hawksley Medal nor the Stanley premiums were awarded this year, the awards to students had multiplied and the young men belonging to the North-Western Branch were taking their full share. Amongst the latest developments of the Institution he mentioned the new branch which had been formed in South America. Professor Stoney replied, and the proceedings were wound up with the toast of "The Hon. Secretary, Mr. Dempster Smith," proposed by Professor Stoney and seconded by Mr. Chas. Day.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HEATLESS COMBUSTION.

SIR,—Mr. Pochobradsky now refutes the conclusion, the absurdity of which I demonstrated in my last letter, and believes that "there is a balance of adiabatic work even in the case of heatless combustion." I have merely gone further and proved that there must be a balance in every case.

I did not, according to Mr. Pochobradsky, "plot" adiabatic curves on a P V diagram; therefore there is no onus on him to accept them as adiabatics. They are simply lines drawn at random through specified end points. Obviously, however, they must intersect some definite number of times between zero and infinity. I have shown them as intersecting once. If Mr. Pochobradsky cares to go over my original proof again, demonstrating the self-contradictory nature of his own original conclusion, he will find it applies to any number of intersections. In other words, the actual forms of the adiabatic curves do not enter into the proof.

My proposition on the efficiencies of ideal gas and petrol engines does not rest on heatless combustion, but on Mr. Pochobradsky's own conclusion that all the adiabatic expansion lines must, at the original volume, pass through what would have been the explosion pressure point at that volume. The resulting efficiency formula is absurd—not faulty—because Mr. Pochobradsky's original conclusion, as he now admits, was faulty.

The terms K_m and K_p were defined as constant by Mr. Pochobradsky and not by me. I have never stated that calorific value, or heat of reaction, is constant with temperature. What I maintain is that thermodynamic analysis cannot be applied to show that calorific value, thus defined, varies with temperature. I have always kept in mind the possibility that heat of reaction may vary with temperature, but should such a fact ever be verified experimentally, thermodynamic theory will not provide any explanation of it. The explanation must lie in some other field outside that involving thermal and mechanical energy exchanges alone.

I have given the commonly accepted definition of calorific value already. Mr. Pochobradsky has quoted it in his letter in your issue of the 23rd ult. I repeat it here:—"The calorific values of fuels are usually obtained either at constant volume or constant pressure, the heat evolved being measured after the temperature of the exhaust products has been reduced to the initial temperature of the mixture. In some cases allowance is made for the difference in the internal energies or total heat energies, as the case may be, at that temperature, but in general at normal temperatures this is so small as to be practically negligible," *i.e.*, the calorific value is given by

$$Q = \int_0^{T_2} C_p \, dT - \int_0^{T_1} C_m \, dT \quad \cdots\cdots\cdots (1)$$

Mr. Pochobradsky's calorific value is

$$Q = \int_0^{T_2} C_p \, dT - \int_0^{T_1} C_p \, dT \quad \cdots\cdots\cdots (2)$$

The allowance to which I refer in the above quotation is simply

$$\int_0^{T_1} C_p \, dT - \int_0^{T_1} C_m \, dT \quad \cdots\cdots\cdots (3)$$

and is the quantity which Mr. Pochobradsky omits from his calorific value.

When $T_2 = T_1$, (1) and (3) become identical and (2) becomes zero, the condition defined by Mr. Pochobradsky as "heatless." He may not have coined the word himself, but he has applied it to this specific condition.

WM. J. WALKER.

Dundee, December 14th.

SIR,—Heatless combustion was suggested by you as an explanation for certain phenomena in connection with explosion of gaseous mixtures; you also gave as an illustration the action of hydrogen on carbon dioxide. This action, according to actual observation, proceeds exothermally until a temperature of 2830 deg. Cent. absolute is reached, at which temperature the action becomes neutral, and above this temperature it becomes endothermic. The problem appeared to me in the light that at some higher temperature a thermochemical action would proceed, the temperature of the products remaining the same as that of the mixture; that particular temperature being called the neutral point and the action at that point you described conveniently as heatless.

I have shown in my letter published in your issue of October 23rd that the amount of heat evolved by the combustion of a mixture at various temperatures varies with the temperature, and with the help of thermodynamics I was able to advance an explanation for the partly exothermic, then neutral, and after that endothermic nature of the action of hydrogen on carbon dioxide. Mr. Walker suggested that my fundamental equation, and consequently the whole analysis, was wrong; but he had to alter his view completely. I have assumed that Mr. Walker endeavoured to throw some light on the problem of heatless combustion; my assumption proved to be wrong, as it is now perfectly clear that the two points he raised, namely, definition of calorific value and a process involving adiabatic compression and expansion, are entirely irrelevant so far as heatless combustion, as raised by you and discussed by me, is concerned. Mr. Walker proves in his last letter that he had for calorific value at least two different terms which differ by a certain allowance. I prefer only one term or two equivalent terms, as long as they do represent what is generally meant by the name "calorific value." I submit that the terms I used fulfil this condition. It is unfortunate if in a discussion two different things are put under one and the same name, or if a conclusion put forward solely for heatless combustion is applied on exothermic action; obviously confusion must result. Those readers who are interested in the problem of heatless combustion would be well advised to free themselves of that confusion, as, no doubt, the discussion of calorific value and processes involving adiabatic compression, and expansion so vehemently pushed forward by Mr. Walker has absolutely no bearing on the problem of heatless combustion, and there is therefore no need for me to add anything to my previous statements. My original equations and analysis remain entirely untouched by such discussion, and it was neither disproved nor replaced by better ones.

Erith, December 16th. B. POCHOBRADSKY.

[This discussion must now cease.—ED. THE E.]

DOUBLE-BOGIE TENDERS.

SIR,—Having made a footplate trip on an express engine fitted with a double-bogie tender, I can personally testify to the unpleasant side swinging of such tenders at the front end when travelling at a good speed.

It may be worth while to add that double-bogie tenders with inside bearings were adopted by Mr. Peter Drummond in 1900 for his celebrated 4–6–0's of the "Castle" series, and also, in the same year, for six 0–6–0's, in each case on the Highland Railway. Succeeding 0–6–0's had, however, six-wheeled tenders.

Double-bogie tenders were also used by Mr. Jas. Manson on the G. and S.W.R. in 1903, for the first ten engines of the 4–6–0 type designed by him. The bearings of these tenders were outside the wheels. Six-wheeled tenders were provided by Mr. Manson for his seven further 4–6–0's of 1910–11.

Again, one of the Great Central 2–8–0's, No. 966, when rebuilt and adapted for burning pulverised coal, in May, 1922, was equipped with an extra large and specially designed tender, carried on two four-wheeled outside-framed bogies. This tender, with 7 tons of fuel and 4150 gallons of water, weighed 52 tons 18 cwt. It is not perhaps generally known that No. 966, as reconstructed in 1922, had a boiler 6ft. in maximum diameter. The cylinders were 21in. by 26in. and the coupled wheels were 4ft. 8in.

Other instances of the employment of double-bogie tenders were those of the imported American 2–6–0's of 1899–1900, seventy out of the eighty engines supplied having tenders of this description, but the engines were not of British design.

Stevenage, Herts., December 21st. F. W. BREWER.

ROYAL INSTITUTION.

THE Christmas Lectures at the Royal Institution are this year to be delivered by Sir William Bragg, who has chosen for his subject "Old Trades and New Knowledge." It is interesting to note that the forthcoming series of these lectures, which are specially intended for juvenile audiences, forms the one hundredth course since they were founded by Faraday. The following are the titles of Sir William's six lectures:—(1) The Trade of the Sailor, (2) of the Smith, (3) of the Weaver, (4) of the Dyer, (5) of the Potter, (6) of the Miner. They will be delivered on (1) Tuesday, December 29th, (2) Thursday, December 31st, (3) Saturday, January 2nd, (4) Tuesday, January 5th, (5) Thursday, January 7th, and (6) Saturday, January 9th, and will begin in each case at 3 p.m.

The following is a list of the Friday Evening Discourses, which have been arranged for the before-Easter session of the Institution:—January 22nd, Sir William Bragg, Fullerian Professor of Chemistry, "The Work of the Davy Faraday Research Laboratory"; January 29th, Sir William B. Hardy, Sec. R.S., "On Films"; February 5th, Professor George Gordon, "Shakespeare's English"; February 12th, Dr. Robert Robinson, F.R.S. (subject not yet announced); February 19th, the Hon. John W. Fortescue, LL.D., Librarian at Windsor Castle, "George III. in his Papers"; February 26th, Dr. C. Hagberg Wright, secretary and librarian, London Library, "Nicolas de Peiresc and his Circle: The Story of a Seventeenth Century Patron of Learning"; March 5th, Sir Henry Maybury, M. Inst. C.E., "London Traffic"; March 12th, Sir J. J. Thomson, O.M., F.R.S., M.R.I., "Radiation from Electric Discharges"; March 19th, Mr. John Tweed (subject not yet announced); March 26th, Sir Ernest Rutherford, O.M., D.Sc., F.R.S. (subject not yet announced).

The following is a list of the general courses of lectures arranged for the forthcoming before-Easter session of the Institution:—Tuesdays, January 19th, 26th, "X-rays and Living Matter," by Dr. James A. Crowther, Professor of Physics, University College, Reading, 5.15 p.m.; Tuesdays, February 2nd, 9th, "Surface Action," by Dr. Eric K. Rideal, Owen Jones Lecturer on Physical Chemistry, University of Cambridge, 5.15 p.m.; Tuesdays, February 16th, 23rd, March 2nd, and Monday, March 8th, "The Egg" (1) Introductory, (2) The Shell, (3) The Yolk, (4) The White, by Mr. Joseph Barcroft, F.R.S., Fellow of King's College, Cambridge, Fullerian Professor of Physiology, 5.15 p.m.; Tuesdays, March 16th, 23rd, "The Growth of Crystals," by Dr. Cecil H. Desch, F.R.S., Professor of Metallurgy, University of Sheffield, 5.15 p.m.; Thursdays, January 21st, 28th, (1) "The Language of Birds," (2) "The Breeding Factor in Birds," by Dr. Charles J. Patten, Professor of Anatomy, University of Sheffield, 5.15 p.m.; Thursdays, February 4th, 11th, 18th, "Who were the Greeks?" by Dr. John L. Myres, Fellow of the British Academy, 5.15 p.m.; Thursdays, February 25th, March 4th, 11th, "The Atom of Light and the Atom of Electricity," by Dr. C. D. Ellis, Fellow of Trinity College, Cambridge, 5.15 p.m.; Thursdays, March 18th, 25th, "The Indecisiveness of Modern Warfare," by Dr. John Holland Rose, Vere-Harmsworth Professor of Naval History, University of Cambridge; Saturdays, January 23rd, 30th, (1) "The Evolution of Currency and Coinage," (2) "The British Coracle, or Skin-covered Boat, and its Affinities," by Mr. Henry Balfour, F.R.S., Curator of the Pitt Rivers Museum, Oxford, 3 p.m.; Saturdays, February 6th, 13th, "The Triad and the Perfect Fourth: (1) Their Nature, (2) Their Uses from Hucbald to the Present Day," by Sir Walford Davies, Professor of Music, University College of Wales, Aberystwith, 3 p.m.; Saturdays, February 20th, 27th, "Roman Britain," by Dr. George Macdonald, Permanent Secretary, Scottish Education Department, 3 p.m.; Saturdays, March 6th, 13th, 20th, 27th, "The Rare Gases of the Atmosphere and their Importance in Atomic Theory," by Sir Ernest Rutherford, O.M., F.R.S., Professor of Natural Philosophy, R.I., and Cavendish Professor of Experimental Physics, University of Cambridge, 3 p.m.

THE official report of the Italian State Railways shows that the financial year 1924–25, during which the railways were administered as an autonomous section of the recently created Ministry of Communications, marks the close of the long period of financial deficits in this important service. The report reveals a remarkable growth in the goods and passenger traffic, while at the same time the average number of the staff has declined as compared with previous years. To meet traffic requirements, important orders have been placed for new engines and other rolling stock. While receipts increased by 658 million lire, expenses rose by 70 million, leaving a net increase of 588 million lire. With this sum the deficit of 412 million for the year 1923–24 has been wiped out, and a net surplus of 176 million remains in hand.

The Drac-Romanche Water Power Undertaking.

FRANCE can be termed with all justice the cradle of armoured concrete construction, and since the war a number of remarkable works have been undertaken in that country which show that engineers and contractors there have been by no means standing still. Armoured concrete has proved to be very useful for many classes of work connected with hydraulics, for drains, sewers, water supply pipes, and in connection with water power development for conduits, flumes, syphons, balancing chambers and pressure pipes.

An interesting example of this construction is to be seen near Grenoble in the French Alps, in connection with the Drac-Romanche power station, where a pressure pipe of 6 m. internal diameter has been constructed working under a pressure of 7 m. to 14 m. head of water, say, from 23ft. to 46ft. Some photographs and diagrams of this work were shown at the exhibition recently held at Grenoble. The power station is situated about 5 miles from the city in a district where there is a good demand for power for such industries as paper and pulp board making, chemicals, dyes, and textiles. The system was initiated because, during the war, existing power supplies could not cope with the industrial demands.

The two streams, the Drac and its tributary the Romanche, both of which are utilised upstream for power generation, have very variable flows, the combined volume of water in the months of May and June, when the rivers are in flood after the melting of the snow and ice on the mountains and table lands of the Dauphiné, exceeds 200 cubic metres, say, 7080 cubic feet, per second. The Drac joins the Isère below the city, this latter river joining the Rhone near Valence. Apart from the pipe itself there are other points of interest with regard to the works.

The total length of the river affected by the installation from head training works to the end of the tail-race is about 3 kilons. The total difference of head is 18 m., say, 59ft., of which about 17 m. are utilised. The mean annual flow is 80 cubic metres per second with a minimum of 30. There are no arrangements made for water storage on these works, although some large schemes are under discussion with regard to the upper watershed. The bed of the river consists largely of a compact ballast, which goes down to 50 m. or more before rock is reached, and this factor made the construction of the foundations of many sections of the works a matter of some difficulty, especially in view of the sudden freshets to which such mountain torrents are subjected.

A barrage is situated a short distance below the confluent of the two torrents. On the west side there are four openings, each 16 m. wide, fitted with balanced sluices, which can be regulated for the flood discharge, then a spillway 60 m. long, which in normal flow conditions is surmounted by a shuttering $\frac{1}{2}$ m. high. There is a sluice for the discharge of pebbles and gravel, of which large quantities are brought down in flood time. This is controlled by a Stoney sluice gate, 16 m. wide, 50 tons in weight, operated by a 50 horse-power motor. The water, in making its way to the intake canal, passes into the gravel depositing chamber and then turns at right angles through fourteen 6 m. openings arranged with grids on the upstream side.

The foundations of these head works were begun during war time, when it was difficult to arrange for steel caissons, and therefore armoured concrete caissons, 20 m. long, 5 m. wide and 8 m. deep, were adopted, sunk without compressed air. They were fitted with steel cutting edges, the sinking being assisted by means of powerful electrically driven pumps. The foundations were carried down 8 m. to 10 m. below the river bed.

The water on its way to the power station passes into a settling chamber 100 m. long, 34 m. wide and 6 m. deep, in which much of the sand brought down can be deposited. This sand can be discharged into the river by means of an electrically driven traveller fitted with a scoop. The entrance canal can be shut off in a few seconds by means of a balanced sluice 8 m. wide for 4 m. depth of water. The canal is 745 m. long. A grid is placed at the entrance of the pressure pipe.

This armoured concrete pressure pipe was constructed to the design of Monsieur Delamarche, of Grenoble, who, as far back as 1899, designed a pipe, 3·30 m. diameter, 2400 m. long, to work under a

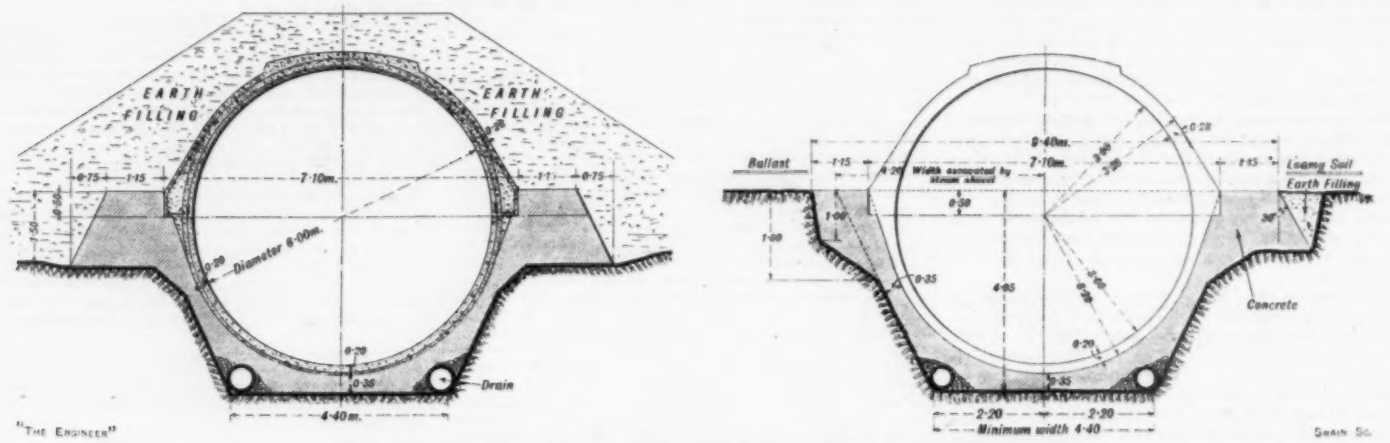
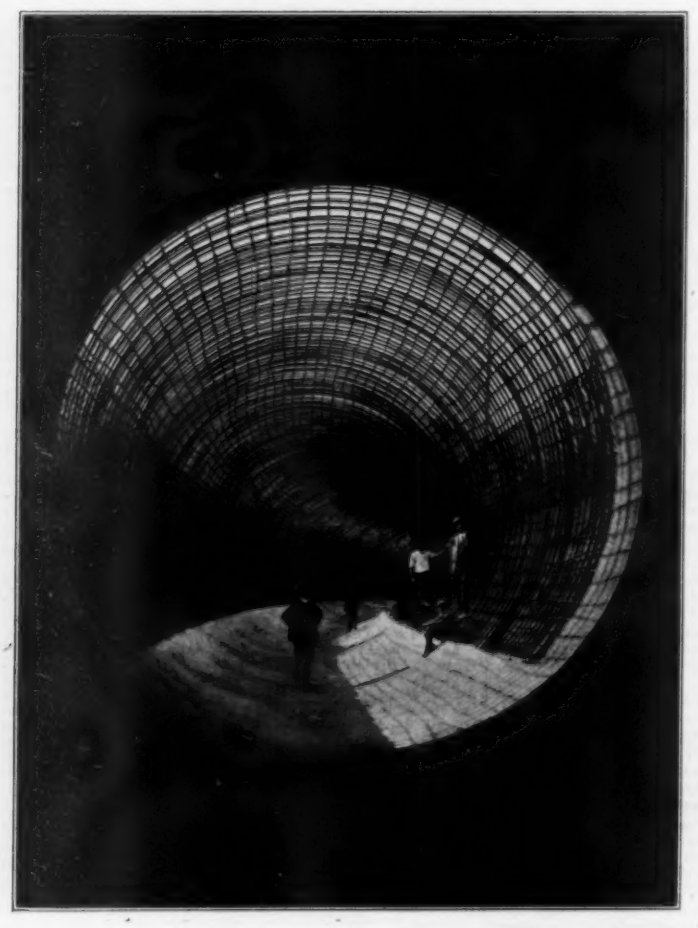
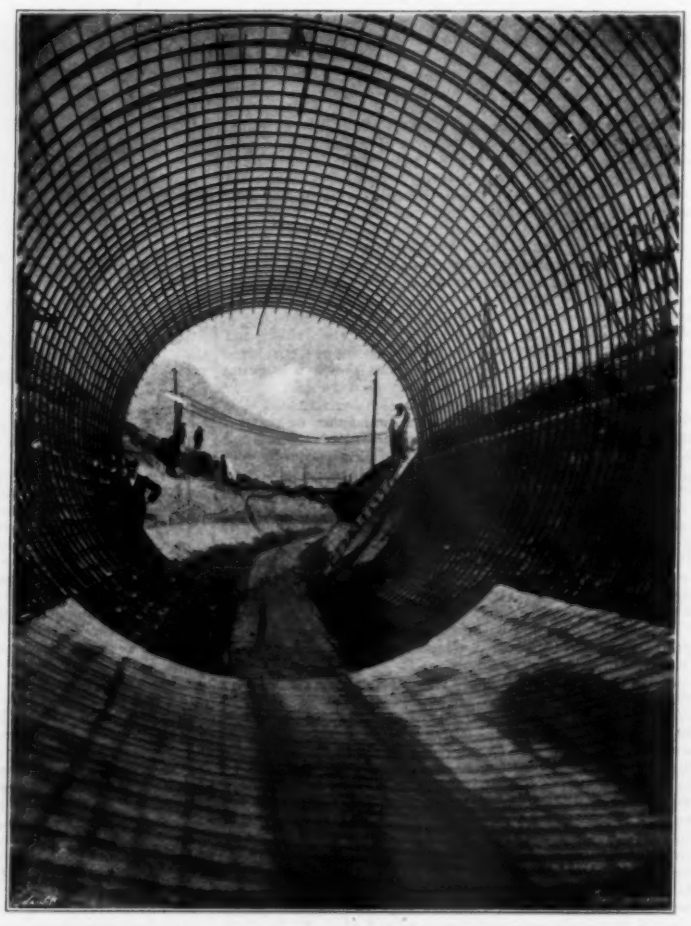


FIG. 1—TYPICAL CROSS SECTIONS OF THE REINFORCED CONCRETE PRESSURE PIPE





FIGS. 2 AND 3—VIEWS IN THE INTERIOR OF THE PIPE DURING CONSTRUCTION

head of 20 m. for a water power installation further up the valley of the Drac. Fig. 1 shows a section of the pressure pipe, which has an internal diameter of 6 m., say, 19ft. 8in. It is constructed in two straight lengths, joined by a curve of 200 m. radius. The total length is 1456 m. There are two concentric rings of reinforcing bars, which are close together at the bottom, but are separated at the crown of the pipe. Sixteen bars are used per metre length, eight for each ring. The diameter of the bars varies from 14 mm. to 22 mm.—0·55in. to 0·86in.—depending on the pressure head in the pipe, which varies from

FIG. 4—STEEL FORM FOR MOULDING SIDES

6·34 m. to 14·25 m. There are longitudinal bars, which vary in diameter and number from 90 of 10 mm.—0·39in.—at the upper end to 135 of 12 mm. —0·47in.—at the lower end. There are also eight supplementary bars per metre run at the shoulders of the pipe. As can be seen from Fig. 1, the pipe proper rests on a concrete trough furnished with drains. Where the ground passed through was of a loamy character the concrete was carried down to the gravel. The water-tight part of the walls are 0·20 m.—7·87in.—thick at the bottom and 0·28 m. —11in.—in the upper part.

A steam shovel was used for the excavation of the

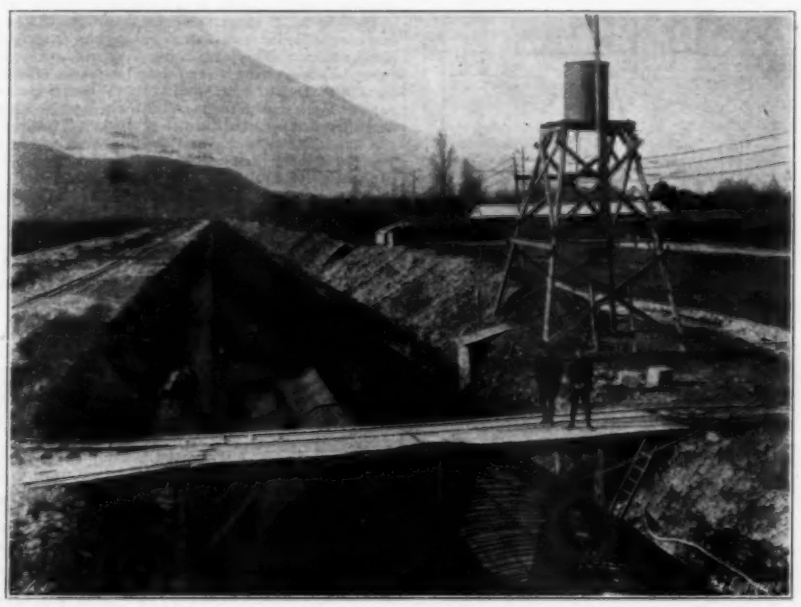


FIG. 5—VIEW ALONG PIPE TRENCH SHOWING REINFORCEMENT

trench. The ground passed through was part of the old bed of the torrent, and, as a rule, after the first metre depth it consisted of a mixture of sand and pebbles, the latter having an average diameter of 10 mm.—0·39in.—and not usually more than 25 mm. —just under 1in. A great deal of the material excavated was used for the concrete in the foundations. After the excavation was completed, drains, designed to carry off 1000 litres per second, were put into the corners of the trench. The foundations of the invert were first put in and then a braced sheet steel form running on temporary rails was used for the moulding of the sides of the supporting trough, as can be seen from Fig. 4. Electrically driven concrete mixers were used.

The problems regarding the quality of the steel and the best methods of fixing the bars were studied in the testing laboratories of Messrs. Bouchayer and Vaillet, of Grenoble, which laboratories were put at the disposal of the engineers of the works. A workshop for the bending and electric welding of the rings was arranged in a convenient position. The bars used were of commercial lengths butt-welded together into long lengths and then cut so as to give 19·80 m. for the outside rings and 20·20 m. for the outside rings. They were bent to a circle in special rolls and then electrically welded up. With the aid of two welding machines 100,000 welds and 20,000 rings were made in seven months.

These rings were taken by trolley to the site and placed in position with the aid of a moving stage running along the invert. Figs. 2, 3, and 5 show the reinforcement in place. The section on the invert was first laid, and then the sides and top with the aid of internal and external movable sheet steel forms. For the pipe walls a mixture of 450 kilos. of cement, 0·5 cubic metre of sand and 0·65 cubic metre of gravel was used. The cement employed was of a comparatively rapid-hardening type, which allowed the forms to be moved ten hours after casting. This type of cement, which is manufactured from local argillaceous limestone, has been made by Messrs. Vicat for a number of years, and is used for such classes of work as that under consideration. It is materially cheaper than "Ciment Fondu."

An electrically operated gantry—Fig. 6, page 696—running astride the pipe on temporary rails was used for making the concrete; this carried an elevator for the aggregate, a concrete mixer, and shoots to take the mixture to the point required. The walls were made in 12·50 m. lengths, 80 cubic metres being required for each section. The internal form was supported on wheels on rails on the already set invert, and, by means of jacks after the cement was set, the upper part was lowered and the form moved forward. The ring was cast in the afternoon and the form moved forward the following morning, one section therefore being made each day. Fig. 7 shows the part of the pipe completed ready for covering. An earth bank was placed over it to protect it from the weather and from temperature variations.

After the tube walls were completed and covered up the joints between successive 12·50 m. sections were touched up by hacking out to a V groove and filling in with a rich cement mortar well rammed; this was done after covering to obviate any temperature stresses which might lead to cracking. The tube was allowed to harden for several months before water was let in, and although several small leaks took place during the first few days, they rapidly sealed themselves up. The construction of the pipe proceeded from first to last without a hitch, and it has proved to be in every way tight and satisfactory. The construction of this section of the works took a year to carry out. It required 12,000 cubic metres of ballast and 3000 tons of lime for the foundations and for the pipe proper 1300 tons of bar steel, 5000 tons of rapid-hardening cement, and 11,000 cubic metres of sand and gravel. The weight of the reinforcement came out to less than 1 ton per metre run.

This pipe, which is said to be the largest concrete pressure pipe in the world, was constructed by the Société Anonyme de Conduites et Potaux en Ciment Armé, of Grenoble, which firm is an offshoot of the Vicat Cement Company of the same city, its engineer being the above-mentioned Monsieur Delamarche.

The station to which the conduit pipe supplies water is built on part of the old river bed. It is protected against floods by a bank 1200 m. long, and is designed to utilise 80 cubic metres of water per second. In order to relieve the conduit from danger from shock, should the loads on the turbines be suddenly shut off, it was desirable to arrange for a large balancing chamber with provision to divert 80 cubic metres of water per second. In view of a project for the utilisation of the same water for another installation further down stream without having to go to the expense of a barrage across the whole river bed, it was desirable for arrangements to be made so that the whole of the water arriving by the pressure pipe could be rapidly diverted into the tail-race should any shutdown take place in the power station.

It was decided, therefore, to build a large armoured concrete tank over the turbines, 50 m. long and 18 m. wide, to act as balancing chamber and forebay with provision for the diversion sluices. The conduit is connected to this tank by means of a rising rectangular bell mouth. The station contains five 3000 horse-power turbines running at 337 revolutions per minute, constructed by Messrs. Neyret-Beylier and Piccard-Pictet, of Grenoble. For a working head of 17 m. the speed of revolution is high. The turbines are of the open-chamber two-wheel horizontal modified Francis type. The vanes are operated by a rapid-acting hydraulic governor. The turbines are connected to 2800-kilovolt-ampère, 5500-volt "Grammont" three-phase alternators, 50 periods. In addition to the usual switching and feeder apparatus there is a step-up transformer house, 5500 to 26,000 volts, by which connection is made to high-tension systems of three power companies which furnish supplies of electricity to the neighbourhood.

It may be mentioned that for the execution of all the works, including the conduit pipe, the power, station and the inlet works extensive use was made of three-phase power supply furnished by two neighbouring power companies, an alternative supply being therefore available. Temporary high-tension lines were run to important points, and step-down transformers were arranged in a number of wooden cabins to supply the three-phase motors used on the works. One of these cabins can be seen in Fig. 5, a low-tension line being run alongside the trench to give current to the different gantries and mechanically operated portable moulds. Owing to the nature of the foundations extensive use was made of electrically driven pumps. Over 100 three-phase motors were used on the different sections of the whole works, aggregating about 2000 horse-power.

The original studies for the complete works project were made by Monsieur Auguste Bouchayer, and the main contractors for the whole works were the Société Générale D'Enterprises, of Paris. The undertaking has now been in operation for several years, and the various original features in the design have justified those who were responsible for them.

ROAD MAKING IN CHINA.

IN his recent official report on the industrial condition of China, Mr. H. J. Brett, British Commercial Secretary, in Shanghai, makes the following remarks concerning the present condition of road transport in that country:—

One of the few encouraging developments noticeable in China within the last few years has been the very marked interest displayed by local authorities and by the public generally in road-building schemes, and in spite of the difficulties created by civil war and widespread disorder, the movement continues to make steady progress. In an article published in a Shanghai journal some months ago, a list was given of roads already constructed in various parts of the country, the total mileage amounting to about seven thousand, and it was stated that this list was by no means comprehensive, there being at least a further six thousand miles of good roads already built or under construction. In the list given in that article practically every province in China is included. Those in which most progress has been made are Kiangsu, Shantung, Shansi and Chihli, and more than half the roads are described as being suitable for motor traffic. Without accepting these figures as being absolutely accurate, there can be no question that a realisation of the necessity for improving the internal means of communication is growing in all parts of the country and that some thousands of miles of roads suitable for at least the lighter type of motor traffic have already been constructed. In some cases these roads have been built by local authorities or charitable organisations as a means of finding employment for disbanded soldiers or famine refugees, but in many instances they are purely private enterprises, the company holding the concession having a monopoly of motor traffic and charging tolls on all vehicles using the highway. This development, which is still only in its infancy, is likely to have far-reaching effects in opening up internal markets, and one immediate result will naturally be an increased demand for motor vehicles, both for passenger and goods traffic. Mr. Brett would like at the same time to emphasise the point that any expectation of an immediate market in China for large quantities of motor omnibuses and trucks, and especially for the heavier types of such vehicles, would be altogether premature. A very large proportion of the new roads constructed in country districts are of a primitive type, insufficiently ballasted, and suitable at the best of times only for the lighter forms of motor traffic, while after floods they may be altogether impassable for considerable periods. The Chinese companies running motor services are, as a rule, provided with little capital, and their main object is to procure a vehicle at the lowest possible price, which can be made to serve their purpose.

Mechanical Couplers for the Indian Broad-gauge Railways.

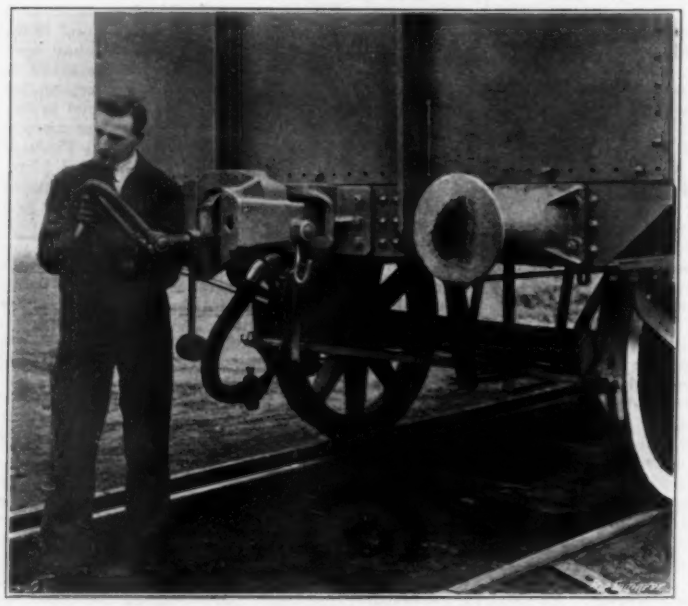
SINCE the article on "Mechanical Couplers for Indian Railways" appeared in THE ENGINEER of March 2nd, 1923, considerable progress has been made towards securing adoption of an automatic mechanical coupler operating in the vertical plane for the broad-gauge rolling stock mentioned. The Railway Board, having accepted in principle, the advisability of a change from the ordinary side buffers and screw couplings to a central automatic mechanical arrangement, deputed an officer to visit the United States for the purpose of investigating the working of mechanical couplers there, and the report he submitted was referred to the Indian Railway Conference Association. That body, after a careful review, made a recommendation to the Railway Board that before any particular make of coupler was chosen, an opportunity should be given to different manufacturers of such devices to demonstrate what they could do in the way of providing an appliance which would satisfactorily meet the Indian requirements, and also to enable the change-over to be easily and successfully made.

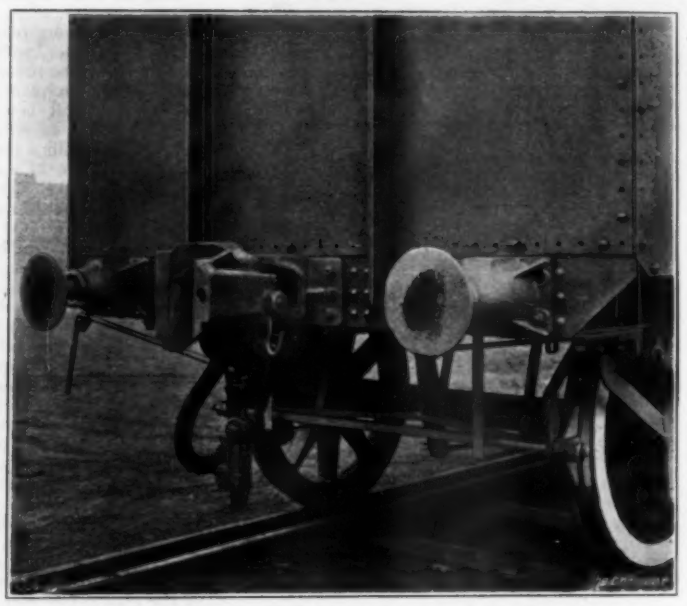
It will be remembered that the proposal put forward at the time of our article referred to above, was to fit the mechanical couplers below the existing underframe, so that the ordinary draw gear would not be interfered with during the change-over period, and whilst vehicles were being equipped with mechanical couplers. It was intended that the couplers should be fitted with their faces 1in. in advance of the buffers, so that if two "fitted" vehicles came together, the couplers would engage and operate before the buffers were compressed. In like manner, if an unfitted vehicle had to be attached to a fitted one, the screw coupling of the former could be thrown over the draw hook of the latter without trouble. In this proposal there was embodied the suggestion that it would be an advantage to adopt, ultimately, carrying wheels for the goods stock of reduced diameter—33in. against the present practice of 43in.—so that the carrying capacity of the vehicles could be improved and better advantage be taken of the limited loading gauge; furthermore, a reduction in tare would also be secured. This method of meeting the case was rejected by the Railway Board, and an instruction was issued that any central mechanical coupler fitted must be placed on the present centre line of draft; in other words, the coupler shank must replace the drawbar. This decision, of course, had a very important effect on any development, as it practically placed the Indian problem on exactly the same footing as that which has embarrassed railway engineers in this country and Europe. It emphasised the absolute necessity of finding a transition method, whereby fitted vehicles could be attached to unfitted vehicles during the change-over period, and so obviate any dislocation of traffic.

Up to this point, the advocates of a central mechanical coupler had in view the M.C.B. coupler of America as the one in more general use, which might be modified to suit their requirements; but the decision of the Railway Board that the existing centre line of draft gear must be maintained had the effect noted above, and threw the whole project back into the "melting pot." A committee of railway mechanical engineers was therefore hastily summoned. From its meetings resulted a suggestion that the difficulty could be met by using a "yoke" suspended from trunnions cast on either side of the coupler head, to carry the link or links, which could then be passed over the hook of the adjacent unfitted vehicle, as usual. Such a proposal was made quite twenty years ago in Germany, but was found to be impracticable in service. The trunnions are subject to breakage, the yoke is likely to be distorted, and the links only provide a slack coupling in place of the present tight screw arrangement.

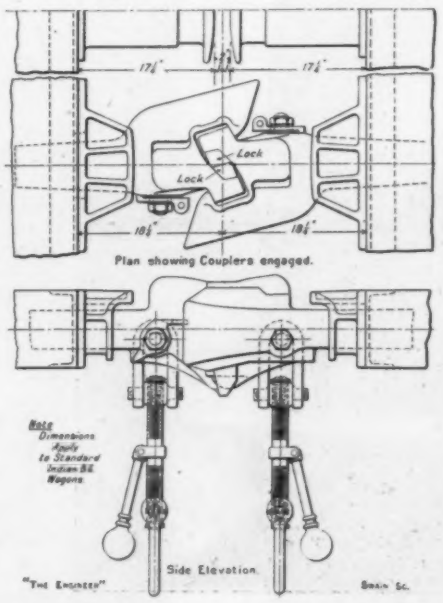
Finally, the proposal of the I.R.C.A. that the matter should be referred to the coupler manufacturers was adopted. Various makers have accordingly experimented during the past twelve months. So far as the finding of a solution in connection with the M.C.B. coupler goes, the matter appears at present to be in a very similar position to that it was in twenty five years ago. The problem is a most difficult one, for apart from the fact that the revolving knuckle of the M.C.B. coupler closes the cavity of the head, thus preventing the introduction of links, difficulties are presented by the limited dimensions to be met in establishing connections with existing buffers. Attempts have been made to rearrange the knuckle and remove the locking gear to the side, so as to clear the jaw of the head for the reception of a link, &c.; but any modification in this direction produces complications with other details to an extent which involves almost complete redesigning. Alterations which appear at first sight simple, on closer investigation reveal the fact that the locking mechanism would have to be entirely remodelled. The head would then become heavy and unwieldy, whilst the knuckle would lose its ability to engage successfully vehicles of varying heights. Hopes of securing satisfactory transition arrangements have proved equally fallacious. All loose links, pins, and detachable parts are out of the question when the operations of ordinary shunting in goods yards are considered.

It is advisable here to refer to the attempts American experts have made to improve and perfect the M.C.B. coupler. That it has its imperfections and shortcomings, there can be no doubt whatever; they have been recognised in America for years past. The number of modifications, improvements, &c., formed the subject of so many patents that they became most bewildering. Numbers of new couplers were constantly being made, and a multitude of the parts liable to fracture had to be kept in store all over the country for replacements. The matter becoming so complicated, the American Railroad Association decided to secure the co-operation of the manufacturers with the railway officers in order to investigate the subject thoroughly, and attempt to devise a standard coupler which should embody all those improvements introduced by the different makers and be suitable for hauling the very heavy trains now common. The investigations of this combined committee provide most interesting reading. They are included in a number of reports issued by the Master Car Builders' Association, from which we learn that innumerable experiments, observations, &c., were made before any definite improvements were devised and recommended. The fact that any new standard coupler must interchange with those already in service, made it essential that it should possess a similar contour, and thereby the investigators were seriously handicapped. Briefly, the result has been the design of a coupler head with a "*revised*" contour, now known as the "A.R.A.," type "D." Had those who were deputed to make this attempt at improvement had a free hand in the matter of "contour," an entirely different outline would doubtless have been adopted, for it is recognised now how much depends on this. As an outcome of this "super" inquiry, one of the largest manufacturing firms felt so convinced that a radical change in contour was essential, that it carried out further investigations, and has since evolved a new coupler which embodies all the good features of a vertical plane central coupler without the disadvantages known to exist with the M.C.B. This coupler is known as the "Willison," and a considerable number have recently been sent to India, and are already in service on the different broad-gauge railways, to demonstrate their ability to meet the particular wants of the case. Very extensive and comprehensive tests are also being made on the Continent in both France and Germany.





WILLISON AUTOMATIC COUPLER ON INDIAN ROLLING STOCK



THE WILLISON COUPLER

The illustrations herewith show the coupler as applied to some new wagons of the Bengal Nagpur Railway, sent out early this year, built by the Midland Carriage and Wagon Company, of Birmingham. It will be seen from them how the ordinary screw coupling hangs from the coupler head, and is ready for the attachment of an ordinary vehicle by simply lifting and throwing the shackle over the hook, as is usual in everyday service.

The drawing shows the construction of the coupler, and it will be seen that it is an extremely simple arrangement. The jaws being V shaped, present an open front, as compared with the closed entrance offered with the revolving knuckle of the M.C.B. When a second coupler enters the first, the locks of both rise and are driven back, and then fall forward into the "locked" position, holding the heads securely against tension or compression. The stresses of either are taken on both sides, not on one side, as in the M.C.B. coupler. This feature permits of the coupler head being made 25 per cent. lighter for a given strength of coupler than those of the A.R.A., type "D" pattern.

Another and very important feature is the fact that the Willison coupler not only provides twice the "gathering range" of the M.C.B.—that is to say, for engagement laterally—it also, by reason of its angular faces, permits of vehicles "angling" in the vertical plane, as when entering or leaving severe gradients. This ability is provided for in the M.C.B. by simply allowing sufficient play—$\frac{3}{4}$in. —for it is clear, if the vertical faces of the knuckles are in close contact over a depth of about 11in.—the depth of an A.R.A. coupler—when the vehicles pass on to or off of an incline, severe stress must be set up; in fact, these stresses are at times sufficient to derail vehicles. With four-wheeled vehicles, where there is considerable overhang, this difficulty is aggravated. The deliberations of the Coupler Committee of the A.R.A. are most emphatic on this point, and herein lies one of the difficulties to be met in adapting the M.C.B. couplers for Indian railways. With the Willison, a clearance of $\frac{3}{4}$in. is ample for all conditions of service, up to a change in gradient of 3 per cent.

It is a remarkable fact that recently, for the first time in railway history, it has been possible to put a number of vehicles fitted with vertical plane couplers into ordinary service for interchange with those having side buffers and couplings, and for the intercoupling to take place without any subsidiary application or adjustment. Hence, the Willison coupler bids fair to provide a very simple solution of a most difficult problem.

LANTERN SLIDES OF CRUDE OIL ENGINES.—Ruston and Hornsby, Ltd., of Lincoln, inform us that in consequence of the receipt of frequent applications from lecturers on crude oil engines for slides to illustrate the firm's latest power units, they have prepared a series of slides showing horizontal and vertical cold-starting oil engines engaged in electrical and waterworks undertakings. They will be pleased to lend these slides to any of our readers who may be preparing papers on modern internal-combustion engines.

Railway Matters.

ACCORDING to the *Iron and Coal Trades Review*, the Japanese railway authorities have decided to adopt the British type of bull-headed rails, in preference to the American style, but will not need to come to this country to supply their requirements.

IN giving evidence last week before the Coal Commission Sir Ralph Wedgwood, the general manager of the London and North-Eastern Railway, said that the four grouped companies paid in 1924 £9,250,000 more for their coal than in 1911, and £7,500,000 more than in 1913. The average pithead price in 1913 was the highest up to that time, but 1924 showed a further advance of 89 per cent. The railway rates for the carriage of coal for the latter period were only 54 per cent. higher.

DURING 1924 the vehicles operated by the Standard Oil Company crossed railway tracks 31,000,000 times without an accident. This is an average of 85,000 crossings a day. This record is attributed to the effort on the part of the management to impress all employees with the need and desirability of careful driving. The company pointed out the dangers of careless driving and furnished placards reading, "This car stops at all railroad crossings." Each driver was asked to pledge himself to co-operate and to evidence his good intentions by displaying the placard on the rear of his machine.

THE new escalators at Trafalgar-square Station, on the Bakerloo line, will be ready for service some time in February. The moving stairway shaft, 78ft. in length, has been driven between the booking hall and a point 45ft. below street level. This tunnel is now in the hands of the plasterers and a commencement is shortly to be made with the installation of the escalators and their machinery. The works include a new subway connecting Cockspur-street with the Bakerloo Station, so that passengers will reach the station from the west side of Trafalgar-square without having to cross the square at this congested spot.

THE report by Major Hall on three buffer stop collisions that occurred in the same bay line at Guildford within three weeks of the opening of the electrical service on July 12th has recently been issued. The connection off the down line into the bay necessitated a rather greater intricacy of brake control—particularly when the major part of the platform is occupied—than is required at most of the terminal stations into which the men concerned worked. The collisions were all of a minor character, and of the type which further experience of that pattern of Westinghouse brake—only to be gained under practical driving conditions—will tend to eliminate.

THE railways are particularly unfortunate over the wages of their shopmen. The question cannot be adjudicated upon by the National Wages Board, as the men do not come under the conciliation scheme. The companies were willing that they should, and the National Union of Railwaymen put that proposal, with the recommendation that it be accepted, before the crafts unions, but the latter declined to agree. The fact is that the latter are afraid that the N.U.R. will get the shopmen into the railway union alone, and so they will not discuss the question with either the companies or the National Union. The dispute has now taken a change for the better. The Ministry of Labour, following the precedent of last year as to the shopmen on the Great Northern section, has decided to set up a Court of Inquiry under the Industrial Courts Act.

ALL records for transcontinental travel were broken on November 4th by the arrival at Vancouver, B.C., of one of the new Diesel-electric cars of the Canadian National Railways, which made the trip from Montreal, a distance of 2937 miles, in three days, the actual running time being slightly under 67 hours. This is the longest unbroken trip yet made by the car, and demonstrates its capability of running long distances. The average speed was 43¼ miles per hour, and at one point 22 miles were covered in a less number of minutes. One of the steepest gradients of the Rocky Mountains was ascended at an average speed of 40 miles per hour. From first to last, the car is stated to have run well. Arranged primarily as an endurance test for the engine, not only did the trip prove that point, but it also showed its speed capacity over long distances, which had not been previously ascertained.

ON July 31st last a light engine came into collision head on with a passenger train at St. Enoch's Station, Glasgow. It is the unusual rule at that station that engines which have brought in trains must, after being uncoupled, remain near the buffer stops until a signal is lowered for them to leave the station. The reason for that rule was that before the engine could be disposed of another train might have to be admitted. Such was the case on the evening in question, but when the driver of the light engine saw the signal lowered for an engine in another road, he, without looking whether or not there was an engine, assumed that the signalman had made a mistake. He therefore, as related in Major Hall's recently issued report, moved out and met the incoming train. Twelve passengers were hurt. Major Hall concludes his report by remarking that no question arises of unusual working or of any misunderstanding of the regulation.

THE railway statistics for September of the Ministry of Transport have been issued as a Stationery Office publication. They show that, compared with the corresponding month of 1924 there was a reduction of 3.4 per cent. in the number of passenger journeys, of 7.7 per cent. in the receipts from passengers and of 5.7 per cent. in the passenger traffic receipts. The loss was, moreover, accompanied by an increase of 2.3 per cent. in the passenger train mileage. There was a falling off of 14 per cent. in the coal, coke and patent fuel tonnage, which led to a decrease of 9.3 per cent. in the total freight tonnage. The total ton-miles showed a decrease of 8.4 per cent. and the freight train receipts one of 5.3 per cent. That decrease was, however, accompanied by 4.4 per cent. fewer freight train miles. The average train load, owing to the fall in the mineral traffic, decreased from 132¾ tons to 127 tons, and the net ton-miles per engine hour from 451 to 436¼.

Notes and Memoranda.

THE names of the two 10,000-ton cruisers to be built for the Commonwealth Government by John Brown and Co., Ltd., Clydebank, are to be Australia and Canberra.

AS a result of metering the household water supplies in Boston, U.S.A., the consumption has been reduced from 105 gallons a day per head to 95 gallons. The consumption in Sacramento is 270 gallons per capita daily.

UP to two years ago only fresh water was allowed to stand in the fire mains of San Francisco. Since then salt water has been used, with the result that corrosion has set in, and the original leakage of 125,000 gallons a day has increased to 225,000 gallons.

A BRIEF description is given in the *Engineering News-Record* of how a 36in. pipe, 720ft. long, in Sacramento, was moved bodily sideways a distance of 9ft. 6in. A trench, 8ft. deep and 20ft. wide, was excavated alongside the pipe. Ropes were passed round the pipe and hitched to five motor wagons, which rolled the pipe into its new position in four seconds.

WITH the advance estimates of the 1925–26 cut of timber placed at the record figure of 1500 million feet, by officials of the Canadian Department of Lands and Forests in Quebec, indications are that the season will be one of the most active, at least so far as pulp wood is concerned, for many years past. Reports state that already there are 3500 lumber camps operated throughout the Province, with the Lake St. John and Chicoutimi districts the centre of greatest activity.

IN describing an electro-magnetic instrument for testing worn hoisting ropes, to a meeting of the Midland branch of the National Association of Colliery Managers, Professor W. H. McMillan said that he had seen photographs of a test made by the instrument in which a rope was passed through it three times in one direction and twice in the reverse direction, and in each case the graph disclosed a break, and the breaks exactly coincided when the records were fitted together.

A PAPER on "A New Method of Measuring Pressures," by G. Allsop (Safety in Mines Research Board Paper No. 16, H.M. Stationery Office, Adastral House, Kingsway, London, price 6d. net), has just been published. The paper describes a gauge designed specifically for measuring momentary pressures, the application in the present instance being to the measurement of the pressure produced when an electric arc is struck. The description of the gauge is published in the belief that it may prove useful to other workers on similar problems.

THE Secretary for Mines gives notice that a type of breathing apparatus, known as the Draeger breathing apparatus, 1924 model, manufactured by Messrs. H. and B. Draeger, Draegerwerk, Luebeck, Germany, has passed the official tests, and that the Board of Trade has decided to approve this type of apparatus in pursuance of No. 11 of the General Regulations dated July 30th, 1920, for use at rescue stations and mines. The approving Order containing a specification and drawings of the apparatus is in preparation, and will be made and published shortly.

THE demand for steel rails in non-producing countries, as judged by the combined exports of the United States, Great Britain, and Germany, is, according to the *Iron and Coal Trades Review*, much less now than it was in 1913; Germany's proportion of the total is notably larger. To September 1st of this year the combined exports of the three countries were about 69,800 tons per month. For the twelve months of 1913 the corresponding total was 121,600 tons per month. In 1913 Germany's proportion of the total rail exports was 34 per cent.; to September 1st this year it was about 52 per cent., with the German total only about 5000 tons per month less than in 1913.

BEFORE a meeting of the Institution of Engineers and Shipbuilders in Scotland, Mr. A. F. Baillie read a paper on "The Commercial Application of Fuel Oil," in which he referred to results obtained by an Italian firm using fuel oil for heating four basic open-hearth steel furnaces of 65 tons capacity each, 36ft. long by 15ft. 6in. broad by about 11ft. high at the centre of the arch. There are five charging doors, and each section is built on the separate arch principle. The furnaces are charged with molten pig iron from a large mixer. The temperature obtained is 1650 deg. Cent., and an output of 150 tons of steel per twenty-four hours per furnace on an oil consumption of from 16.5 to 18.75 tons is reached.

THE use of waterproof bags for packing and transporting dry chemicals, in place of the usual boxes, barrels or drums, is, according to the *Chemical Trade Journal*, steadily on the increase. Some users, we learn, are satisfied that the employment of such bags results in savings as high as 50 per cent. The new style container is a heavy jute bag, with two inside liners of heavy kraft paper and a coating of asphalt cement between each layer, applied hot. This construction has proved quite adequate to withstand heavy handling. The bags are closed at the top with a simple wire tie that is quickly fastened. One of the most important advantages possessed by waterproof bags is their low initial cost. There is also saving in tare weight that not only facilitates handling, but may result in a notable reduction in carriage and haulage charges.

IN 1913 there were, says the *Iron and Coal Trades Review*, twenty-four electric furnaces at work in France; they were used for making steel, and produced in that year 21,124 tons of ingots and castings and 11,700 tons of finished products. There was a large number of electric furnaces in use for making ferro-alloys, and their aggregate output was nearly 30,000 tons. At that time there were in France, twelve electro-metallurgical concerns, with an aggregate capital of 41,600,000f., not counting bonds. To-day there are some twenty-two concerns, of which a certain number produce both ferro-alloys and calcium carbide. The share capital of one of these is as much as 200,000,000f. The principal descriptions of ferro-alloys made by them in electric furnaces are ferro-silicon, ferro-chrome, ferro-manganese, silico-manganese, silico-spiegel, ferro-tungsten, ferro-molybdenum, &c. Some of them produce special kinds like ferro-vanadium, ferro-uranium, ferro-tantalum, &c. In 1924 the output of ferro-manganese alone was between 20,000 and 30,000 tons.

Miscellanea.

THE Controller of the Japanese Patent Office is to visit this country shortly.

THE University of New Brunswick is to establish a new Chair of Electrical Engineering.

ARRANGEMENTS have been made for the foundation of a broadcasting station at Seoul, Korea.

THE power station at Portsmouth Dockyard is to be equipped with six land type Yarrow boilers, with superheaters.

THE Stafford Town Council has decided to have an ammonium-sulphate recovery plant at the gasworks. It is to cost £10,000.

A PLANT for the manufacture of oxygen by the liquid air process has been installed at the Great Western Railway Works at Swindon.

THE first shipment of Russian coal for many years past recently arrived at Alexandria. It amounted to 3500 tons, and came from Mariupol.

THE coke-making plant at Krugersdorp, South Africa, is to be extended considerably, especially in the direction of the recovery of by-products.

THE second of the 1300-ton sunken German destroyers has been raised at Scapa Flow by Cox and Danks, Ltd. This brings the total up to twenty vessels salved.

THE Electricity Commissioners have granted an order to the Teignmouth Electric Lighting Company for the supply of electricity in several villages in the Newton district.

THE Salford Corporation proposes to centralise the whole of its transportation system, and for this purpose is to build a large garage capable of accommodating the whole of the municipal vehicles.

THE output of coal from the mines of Great Britain for the week which ended on December 5th was 5,208,600 tons, as compared with 5,336,300 tons for the corresponding week of 1924.

NATURAL gas has been discovered on the river bank of the North Saskatchewan River, Canada, and, according to Professor W. G. Worcester, it indicates the possibility of finding oil also.

A TRADE and information office for the East African Dependencies is about to be opened at 32, Cockspur-street, London. Colonel Franklin, H.M. Trade Commissioner in East Africa, will be in control.

IN connection with the electrification of the Chile State Railways, Ferranti Ltd. is supplying two 13,333-kilovolt-ampère, 110,000-volt three-phase transformers, together with several smaller units.

IT has been decided by the International Executive Committee of the World Power Conference to set up permanent and thoroughly representative National Committees of the participating countries.

CONSTRUCTION is under way on the 500,000 dollar storage and power dam on the Mushkosh River, in the Muskoka Lakes district of Ontario. This work is designed to control the flow from the Muskoka Lakes basin and to link up this power with the Eugenia-Severn system.

THE Boksburg, South Africa, Town Council has decided to close down the trackless tram system and substitute therefor a service of motor omnibuses. The tram system has for some time been operating at a loss, and it is anticipated that better results will be obtained with omnibuses.

THE plant in the Lots-road power station of the London Underground Electric Railway Company is to be extended by the addition of a 15,000-kilowatt Parsons turbo-alternator. The generator will be by the Metropolitan-Vickers Company and the condensing plant by W. H. Allen, Sons and Company.

IN 1924 New Zealand imported 1176 British touring cars, worth £318,398, as compared with 368 of a value of £125,469 in 1923, and 100 in 1922 valued at £44,735. British India took 1011 touring cars in 1924, valued at £299,571, as compared with 202, valued at £166,027, in 1922; and 433 commercial vehicles, as against 63 in 1922.

THE Governors of Loughborough College, Leicestershire, are inviting applications for five open scholarships in the Faculty of Engineering, open to British subjects in any part of the Empire. Forms of application must be returned to the College Registrar not later than March 1st, 1926, and the entrance examination will be held on May 27th, 28th and 29th.

IT is reported by the National Federation of Iron and Steel Manufacturers that the production of pig iron in November amounted to 494,100 tons, compared with 473,700 tons in October and 583,500 tons in November, 1924. There were 141 furnaces in blast at the end of the month, a net increase of 5 furnaces compared with the number in blast at the beginning of the month, 6 having been put into blast and one blown out. The production includes 153,000 tons of hematite, 171,500 tons of basic, 124,400 tons of foundry and 20,000 tons of forge pig iron. The production of steel ingots and castings amounted to 653,800 tons, compared with 652,400 tons in October and 674,300 tons in November, 1924.

LECTURING recently on "London's Housing," at the London County Council School of Building, Mr. G Topham Forrest, architect to the London County Council, said: "In the future development of the London County Council housing estates, particularly Becontree, greater use will be made of concrete. In the past objection has been raised to concrete houses on the ground that there is something very monotonous in a long series of dingy grey concrete houses. In America they have overcome this objection by the introduction of coloured material into the concrete, and a similar method is to be adopted on the Council's estates. It is now possible to obtain Portland cement manufactured in various colours, and it is practicable to introduce variety into the appearance of the rough-cast houses by using these cements. Colours which approximate to those of red and stock bricks offer an opportunity for experiment which promises to be successful."

DRAC-ROMANCHE WATER POWER PIPE LINE

(For description see page 692)

FIG. 6—TRAVELLING GANTRY FOR THE CONCRETE MIXER ASTRIDE THE PIPE

FIG. 7—FIRST PORTION OF PIPE COMPLETED AND READY FOR EARTH COVERING

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The Engineer

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

The Metallurgist

THE DECEMBER NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

DECEMBER 25, 1925.

A Shipyard Agreement.

MANY attempts have been made to prevent labour troubles by written bonds. Not one of them is completely successful, but it would be a mistake to suppose, because strikes do still occur, that such agreements are valueless. Their effectiveness is not to be measured by the conflicts that arise in despite of them, but by the disputes which are settled, unheard of, by the machinery which they provide. The prophylactic efficacy of vaccination is not questioned because now and then inoculated persons die of small-pox. The famous Shipyard Agreement of 1912 failed indeed to stop the great dispute of 1924, but there can be little doubt that it arrested many others before they could come to a head. It is desirable to remember this fact when considering the new agreement which has been drawn up by the Shipbuilders Employers' Federation and the Federation of Shipbuilding and Engineering Trades, and which has been submitted by the latter, with commendation, to the ballot of the affiliated unions.

The first impression on reading the published accounts of the agreement is that it can do no more than is now done by existing machinery or by ordinary shipyard routine. Take, for instance, the first step in any matter in dispute. It is provided that a workman or deputation of workmen shall be received by their employers in the yard or at the place where a question has arisen, by appointment, within two days from the time of request for an interview, for the mutual discussion of the difficulty that has arisen. The only part of that clause which offers any departure from the usual course which is followed in any well-organised shipyard is the time limit. Nowadays, if a question arises in the yard, the manager sees the men involved and endeavours to settle the matter summarily. But if he happens to be absent, an interval of several days may elapse before any steps are taken. The agreement makes it imperative that action shall be taken within two days, and, hence, aims at avoiding an irritating delay. It is perhaps significant that the clause does not prescribe two "working" days. The omission appears to indicate that even if a difficulty arise at ten o'clock on a Saturday morning, the management must endeavour to settle it by ten o'clock on the following Monday. If this ordinary shipyard and workshop routine fails to settle the matter out of hand, there still remain three further days of grace in which, what we may call, informal discussion may continue. In this provision we see again recognition of the desire to prevent delays and of the fact that most matters in dispute can be settled by very simple machinery in a very short time. The ordinary questions of demarcation can, for example, be solved by a tactful manager in a few hours, if not in a few minutes. It is the extra-ordinary cases which take time and on which the resources of larger machinery must be turned. This machinery takes the form of a "local" conference between the employers' local association and the responsible local representatives of the union or unions concerned. In this provision, also, there is little or no departure from general practice, but again a time limit is set down. The conference must, at the request of either party, be called within ten days. Furthermore, if a further step has to be taken, then the matter may be brought before a central conference, and such conferences are to be held fortnightly. Failing agreement at one of them progress must continue with the same rapidity. A "general" conference may be convened, but it must be called within three days, and must meet within fourteen. If it does not succeed at once, it must meet again in not more than ten days. If it fails altogether to reach a satisfactory conclusion, then, and only then, the matter may go to arbitration. It will be seen that the agreement is a four-fold rapid filter for disputes. First, summary settlement within two days, then settlement within a further three days, then a wider discussion within ten days at a local conference, and, finally, within fourteen days a central or general conference. It is only if a dispute is unsettled after it has been riddled through these four successive stages that, by mutual consent, it goes to arbitration. Until the last of the four stages has been tried and has failed "there shall be no stoppage or interruption of work, either of a partial or general character, by members of the Federation or of any union parties to this agreement." Thereafter, full "freedom of action is reserved both to the Federation and to the unions."

It is, we hope, clear from this summary of the agreement that its main object is the acceleration of discussion upon matters in dispute. In few affairs is delay more dangerous than in those connected with labour. There are never lacking those who rejoice in stirring up trouble and the longer they have to do it in, the more serious are the ultimate results. Anyone who has studied the history of labour disputes knows how frequently charges of dilatoriness are made, and anything that can remove those charges must make for good. If this agreement is endorsed, a definite schedule of times will be set up, and for any departure from it the defaulting party will be held responsible by both those directly concerned and by the public. That is, in short, as we see it, the gist of the agreement. It does not provide any new mechanism for the prevention of strikes or lockouts. The processes are the same as those that are now practised, but instead of following each other in uncertain order and in indefinite times, the programme is laid down definitely and precisely. Both parties know what step must be taken and how long there is to take it in. We have some hopes that the four-fold filter, as we have called it, may arrest more strikes than are stopped by the present similar, but indefined, methods, but it must not be expected that it will prevent all shipyard troubles. That is past all hoping until the great problem of demarcation has been solved, and until inter-union disputes are brought to an end.

The Use of High-pressure Steam.

DURING the last few years the term "high-pressure steam" has taken on a new significance. Not so very long ago it could have been fairly applied to any pressure exceeding 200 lb. per square inch, but so great has been the progress in the art of generating and using steam that, at any rate so far as power station practice is concerned, the high pressure of a generation ago is the low pressure of to-day. Neglecting the pioneer work of Jacob Perkins, which fell on stony ground, the first step towards the use of modern pressures was the adoption of a boiler pressure of 275 lb. per square inch at the Carville station of the Newcastle-upon-Tyne company in 1913. This station at once established a record for thermal efficiency, and its success emboldened the company to advance to so high a gauge pressure as 475 lb. per square inch in its North Tees station some four years later. The

opening of the latter station really marked the commencement of the modern era of high pressures. It demonstrated that such practical difficulties as there were could be overcome, and that the theoretical advantages of higher pressures and temperatures could be largely realised. Caution or conservatism has so far prevented the general adoption in new power stations of pressures as high as that in use at North Tees, but much higher pressures are now in successful use abroad. The American Gas and Electric Company has had two very large stations, at Philo and Twin Branch respectively, operating for more than a year at a pressure of 550 lb. per square inch. The new Crawford-avenue station at Chicago, for which a 50,000-kilowatt Parsons turbine has recently been supplied, works with a boiler pressure of 600 lb. per square inch. Three boilers working at a pressure of 725 lb. per square inch have recently been put into operation at the Langerbrugge station of the Centrales Electriques des Flandres. The Atmos boiler at 1500 lb. per square inch has been working in Sweden for some time, and several tests have been carried out on the Benson boiler at Rugby at a pressure of 3000 lb. per square inch. Although these latter types do not fall within the category of central station practice at present, their development is interesting as showing the trend of events. Indeed, it will not be long before we have information as to the performance in service of the 1200 lb. Babcock boiler at the Weymouth station of the Edison Illuminating Company, which is notable for the construction of the drum as a one-piece forging, with wall thickness of 4in. The same kind of drum construction is being used for the 650 lb. boiler which is shortly to be installed at Amsterdam. This boiler is remarkable also for its size, being designed for the enormous evaporative capacity of 180,000 lb. per hour at normal rating. The drum is 4ft. diameter by over 34ft. long, and double circulation through the tubes is adopted.

There are other high-pressure boilers in use or under construction for power stations, and a start is being made in marine practice by the 550 lb. Yarrow boilers now being built for a vessel on the Clyde. Enough, however, has been said to show that high-pressure steam has already taken a definite place in modern practice. With regard to the safety of boilers under such pressures, Sir James Kemnal has expressed himself as perfectly satisfied. Discussing the subject at a meeting of the Institution of Marine Engineers about a year ago, he raised the interesting point that whereas the bursting pressure of a 200 lb. boiler, with a factor of safety of 5, could conceivably be reached in practice, no attainable pressure could burst a 1000 lb. boiler constructed with the same factor of safety. Such boilers as burst, however, always do so at a pressure much lower than that at which the designer thought they would, so Sir James' argument has its limitations. Corrosion, abuse and bad workmanship may nullify all the margin of safety allowed by the designer, and the higher the pressure the sooner will original or acquired defects become dangerous. Fortunately, up to the present no serious accidents have occurred with high-pressure boilers, and with proper care there is no reason to anticipate any. Furthermore, the opinion of users of very high pressures seems to show that the minor troubles have been much less than many people would have imagined. The metal-to-metal joint with a corrugated steel ring between the flanges, seems to have solved the question of steam-tight pipe joints. The breakage of gauge glasses has been abolished by the development of water-level indicators and the consequent elimination of gauge glasses altogether. The only outstanding trouble at the moment seems to be the cutting of valve seats by the leakage of steam at high pressure. With improved design and more suitable material, this difficulty is likely to disappear. At Weymouth, and also, we believe, at Langerbrugge, the main safety valves are protected by small pilot valves set to lift at a slightly lower pressure. When these blow, they serve as a warning to the fireman, who then takes steps to reduce the boiler pressure in order to prevent the main valves coming into operation. The pilot valves, being not essential to operation, can have their seatings attended to when necessary. A peculiar feature of the progress being made towards higher pressures is the erratic nature of the advance. In England, after the 475 lb. of North Tees we have 375 lb. at Barking; in America after the 1200 lb. at Boston, we find 400 lb. chosen for the new 600,000-kilowatt station at Richmond; and on the Continent of Europe the 650 lb. of Amsterdam will follow the 725 lb. of Langerbrugge. Meanwhile, the more conservative engineers in all countries are still putting down important plants for pressures well below 400 lb. Making all allowances for the special circumstances of individual stations, there certainly appears to be a wide divergency of opinion as to what are the optimum steam conditions for a large modern power plant. The increased thermal efficiencies corresponding to higher and higher pressures and superheats are calculable with great accuracy, but a time comes in the opinion of every engineer when any extra efficiency to be gained is more than offset by the extra expense, risk and trouble which the appropriate equipment would incur. The point at which the game ceases to be worth the candle is at the moment almost entirely a matter of individual judgment; hence, the wide diversity of practice. As data become available as to the overall economies as well as to the thermal efficiencies obtained by the present pioneers, practice will no doubt settle down and a comparative standardisation of pressures and temperatures for large stations will be arrived at. The upper limits of these two factors were discussed by Professors Mellanby and Kerr a year ago before the North-East Coast Institution of Engineers and Shipbuilders. These authors considered that with such materials as are available a pressure of 1250 lb. per square inch and a steam temperature of 900 deg. Fah. could not be properly exceeded. The former, it will be noted, is closely approached by the Weymouth station already mentioned, while the temperature of 842 deg. Fah. which has been adopted at Langerbrugge is also well on the way to the other limit specified.

It is, of course, not in the generation of steam at these high pressures and temperatures that extra efficiency is to be expected. The Bow power station in London, with a steam pressure of only 265 lb., has already shown a boiler efficiency exceeding 84 per cent. over a month's ordinary working, and any possible margin for improvement on this figure is at least as open to a low-pressure station as to one at a higher pressure. A perfect boiler, working at any pressure, would have an efficiency of 100 per cent., but the efficiency with which the heat supplied can be turned into work by a perfect plant will depend both on the quality of the steam furnished and the nature of the thermal cycle. Taking the well-known Rankine cycle as representing ideal conditions when regenerative heating is not adopted, a perfect turbine working with 300 lb. absolute pressure, a temperature of 650 deg. Fah., and a vacuum of 29in., can turn about 34.8 per cent. of the heat supplied into work. Raising the pressure alone to 1000 lb. will increase the proportion to 38.5 per cent.; raising temperature alone to 800 deg. Fah. will result in an efficiency of 35 per cent.; whereas if both temperature and pressure are simultaneously raised to the figures given the resulting efficiency will be 39.6 per cent. It will be noted that what may be called permissible pressure rises are theoretically much more conducive to efficiency than permissible temperature rises, the reason, of course, being that the higher the pressure at which steam is generated the higher the temperature at which the main part of the heat is put into the working fluid. With regenerative feed heating and steam reheating, as adopted in large modern power stations, not only would the cycle efficiencies be considerably greater than those given above for the Rankine series of operations, but for any specified vacuum and steam temperature, the theoretical advantage of raising the pressure becomes somewhat more marked. The extent to which these theoretical cycle efficiencies can be approached in practice is another matter. Indeed, it is more often a question as to whether it is economically sound to strive even for the highest attainable thermal efficiency. Extra high-pressure plant costs a lot of money, for besides the special types of boilers and turbines required, there are also the feed pumps, feed and steam ranges and innumerable fittings to be considered. By maintaining moderate pressures and raising temperatures to higher values than have yet been adopted, although the increase of theoretical efficiency is by no means so great, the only portions of the plant to be affected would be the superheater, steam range, the high-pressure end of the turbine and sundry fittings. The possibilities of this alternative have been discussed by Professor A. G. Christie and D. C. Turnbull in a recent report of the Prime Movers Committee of the National Electric Light Association on "Higher Steam Pressures and Temperatures." Anticipating the availability of metal which will stand working temperatures of 1000 deg. Fah. at moderate pressures, they give calculations to show that a 30,000-kilowatt plant using steam at 400 lb. pressure and 1000 deg. temperature should show a thermal performance as good as that of a plant of equal size using steam at 1200 lb. pressure and 700 deg. temperature, a regenerative cycle being assumed in both cases. The authors themselves admit that several of their assumptions are open to doubt, and their conclusion is certainly not one to be accepted without question. The advantages to be gained by increasing temperatures to a point beyond the range of existing practice are, however, certainly considerable, and if metallurgists can provide material which will permit of this, not only will steam practice be benefited, but we may be one stage nearer to the day of the gas turbine—unless, indeed, red-hot steam takes away the advantages of using a gas turbine at all.

Literature.

Colliery Working and Management. By H. F. BULMAN and Sir R. A. S. REDMAYNE. Fourth edition. London: Crosby Lockwood and Son. 1925. Price 42s. net.

A DOZEN years ago the output of coal in this country was about 30 per cent. greater than it is now, and it was produced by 10 per cent. fewer men. Now the householder pays over 100 per cent. more for his fuel, and everybody is dissatisfied, more especially the miner, who says the real value of his wages is in the neighbourhood of 50 per cent. less than it was before the war. Evidently there is something wrong somewhere. Possibly it lies in imperfect observation of what are presumed to be the facts, but more probably we are all hopelessly wrong in our deductions and inferences from data that really cover only part of the ground. Just as in the eighteenth century, it was held to be clearly proved that the population of London was decreasing because the bills of mortality showed fewer deaths year by year. Now, of course, it is well known that the death-rate per thousand was diminishing owing to the increased healthiness of the town, and accordingly while the total number of deaths was lessened, the population was steadily growing. Meanwhile the miner gets less wages and fewer luxuries than the municipal dustman; and a Coal Commission is sitting in Westminster Hall to see what can be done or suggested to be done.

The politician and the public are puzzled. One section of the body of the miners demands nationalisation as *the* panacea. The local coal merchant protests loudly that he is innocent of any attempt to "regulate the vend" like the Newcastle coalowners did for London up to the middle of the last century, but asseverates that all his profits go to pay railway carriage and horse cartage. The low temperature carbonisation man takes the opportunity to push his semi-cokes. And all the while the million odd miners and the forty million odd consumers stumble on in this country, more or less in the dark as to how the wealth or the profits, the yield of the industry, or the allotment of the turnover is really distributed amongst capital, overhead charges and labour.

Bulman and Redmayne's book on "Colliery Working and Management," recently published this year (1925), does afford a good deal of light on these problems, as showing what the actual costs of coal mining have been and are. The technical side of the book will be dealt with later, but attention may first be directed to the pecuniary aspect of working. Most of the figures of costs, it must be confessed, relate to pre-war times, to 1913 or to 1904, and even in some cases to as far back as 1896, when the first edition was published. But this, the fourth, edition has been revised and considerably enlarged, and a gallant attempt has been made to introduce, as far as possible, costs and statistics up to 1923, the latest available at the time of revision. It is not always quite clear to what date the figures refer, but ambiguity is generally removed by the context or by a footnote. As the authors remark on one schedule of prices (page 303), "These are all pre-war examples, most of them dating back to twenty years or more, but as basic figures they still hold good in many cases, a percentage being added."

The manager knows the prices paid in his district, and can easily add the necessary percentage for, say, a stone drift, or for working in the "whole" or "broken," and can compare his own with other districts of which the details are here assembled. In particulars of that nature, of course, the public cannot be expected to take much stock, but the eleven tables given on pages 308–329 are of the very greatest general interest, even if they are not up to date, as they give for a number of collieries some indication of the number of miners and other labourers in relation to total and individual outputs, the time that the men are at work, and the wages they get. The figures, at first sight, vary in an astonishing fashion. Thus the hewer who actually cuts the coal gets anything from 2 to 4 tons per shift, while the average for all the men employed may vary from 1 to 1¼ tons or thereabouts. Of course, this depends mainly on the nature of the coal seam, its depth and the kind of roof and floor; but the enthusiasm of the labour and the efficiency of the management is

accountable for much. Even with these variations in individual collieries, however, it is difficult to explain why the total annual output divided by the average number of men employed should fall somewhere about 30 tons a year. As the authors say, the chief impression left by a historical review of coal-mining in the United Kingdom is the enormous progress made during the last two or three generations in every respect except the return made to capital. It is very doubtful, however, whether capital ought to expect a greater percentage return after due provision has been made, when it is a wasting asset as it is in the case of collieries and mines. It is the third party, the consumer, who has to be considered as well as the capitalist and the workman. His interest is to pay not more than a fair proportion of the cost, or, in other words, a reasonable percentage on the turnover of the parties who supply him. Possibly the authors or the reader will not consider the total turnover, of which particulars never appear in company accounts, as of such vital importance, but they should read two recent books—"My Life and Work," by Henry Ford, and "The Confessions of a Capitalist," by Ernest J. P. Benn. Mr. Benn takes 6d. in the pound out of his annual turnover of £400,000, and considers that one 3d. is his agency fee for each £1 of wages that he produces for the employees in the very big business that was accumulated out of the void; the other 3d. is his wage for each £1 worth of books he supplies to the public. It is not a great remuneration for finding wages for workers and reading for the public, especially as the Chancellor of the Exchequer annexes half of it as income tax and super tax. Anyway, it is clear that the political economists, whether of the order of Adam Smith or of Marx, have not yet got to the bottom of their science.

Turning now to the more technical side of the book, very considerable additions to the matter in the last edition have been made as regards methods of long-wall and of pillar-and-stall working in all their various modifications. Whatever system is employed, it is evident that a uniform rate of advance and a strict adherence to methodical timbering gives the best results in output and in safety. Curiously enough, however, the authors make no reference to hydraulic stowing, which, despite its cost, will enable practically all the coal to be extracted and will permit adjacent seams to be worked with the minimum of mutual interference and settlement.

Twenty years ago no use was made of underground conveyors, and all the coal had to be man-handled some distance from the working face to the tubs if they could not be brought to the place where the coal was kirved and broken down. Now there are well over a thousand conveyors, shaking or belt, in use, and many of them deliver direct into the trams on the haulage roads. Their growing use, more particularly in large collieries, will necessitate modifications in the haulage systems and more extensive recourse to skip winding, thereby saving the useless lifting of the deadweight of the trams. These matters are perhaps rather related to colliery engineering than to colliery management, with which the present work is more particularly concerned, and are of greater interest in anthracite mines in America than in the majority of British mines, where the tenderer bituminous coals are worked and breakage has to be reduced to a minimum. Yet, in the future, round coal should be of less importance in view of improved methods of using slack, when the getting and utilisation of every ounce of fuel is of importance.

In their treatment of mechanical coal getting appliances, the authors are not very consistent or satisfactory. After remarking (page 133) that "it is disappointing to note that during recent years, since 1913, there has been a steady fall, year by year, in the output per machine," they qualify their statement by a reference to the increasing use of percussive machines, which notoriously give a very much smaller output per machine than the chain, disc, or bar type. Many of the percussive type are rather of the nature of hand tools than machines—appliances very similar to riveting, caulking, cutting and concrete-breaking tools, either held in the hand or on a standard. Of a larger size and mounted on a wheeled box, like the Ingersoll-Sergeant coal cutter—these appliances really are machines, and it is not clear whether the hand tools are included in the statistics of machines in use. At any rate, this chapter requires further revision. It is instructive on this point to turn to the evidence of the Institution of Mining Engineers given before the Royal Commission which is now sitting. This evidence, after noting the greater suitability of machine cutting to Scotch than to English mines, shows that "the expenditure for machine mining equipment for a given seam is the same whether an eight hours or a seven hours shift is worked, but in the latter case the output per shift out of which the interest on the capital cost of the machine equipment has to be found is lower, and this has the effect of rendering the introduction of face machinery in any given circumstances less attractive for a seven hours than it would be for an eight hours shift basis."

The book is well printed and well illustrated, except for a black patch in Fig. 17, page 136, to represent a bar coal cutter, and for a figure and a table on pages 242 and 278 that one has to turn the book upside down to read. To the miner and the manager and to the reader of the evidence before the Coal Commission, we can recommend this fourth edition; while to the colliery engineer we can only say that he will be well advised to add it to his library.

Motorships. By A. C. HARDY, B.Sc. London: Chapman and Hall, Ltd. 1925. Price 15s. net.

MR. HARDY will be known to some of our readers as the author of "Merchant Ship Types." That book has now been followed by the eminently readable volume "Motorships," which may be best described as an investigation into the characteristics of mercantile vessels which are propelled by internal combustion engines. Books on marine oil engines which deal with the design and the construction of the motor itself are not wanting, but Mr. Hardy approaches his subject in a somewhat different manner. He is not so much concerned with the oil engine as with the motor ship itself, its rise as a specialised type of ship, its evolution, and the distinctive problems it presents. In the book various aspects of the motor ship are gathered together, and commented upon, and if the chapters sometimes lack a certain continuity, it must be borne in mind that the author regards this volume as only forming, as it were, an introduction to the subject. The book throughout is well illustrated with drawings and views of motor vessels.

In the first four chapters the author discusses the construction of the marine oil engine, and particulars are given of the leading types of marine Diesel engines, hot-bulb engines, and the few gas engines which have been applied to ship propulsion. After a further three chapters devoted to auxiliary machinery and typical engine-room arrangements, there is a section on indirect or transmitted drives, in which an account is given of ships in which the electric, hydraulic or geared form of transmission is employed. A special chapter deals with the Still marine oil engine and its applications.

Under the heading of "Operation," Mr. Hardy discusses such questions as the effect of the marine oil engine on hull construction and tonnage classification, whilst the later chapters of the book contain a series of descriptions of motor ships designed for passenger and cargo work and for special duties, such as locomotive carrying, ferry work, tugs, pleasure yachts, river and other motor craft. Finally, the subject of oil fuels is touched upon, and reference is made to such problems as centrifugal purification and the separation of oil from bilge water by suitably designed apparatus. There are two appendices and also a somewhat short glossary of technical terms. In one the questions which have to be decided in choosing machinery for a motor ship are briefly set forth, and in the other outlines are given of notable motor ships of historical interest. We do not hesitate to recommend this volume to all interested in the motor ship and its recent development, more particularly those who desire to obtain all-round information regarding this subject which is not severely technical in character.

A History of Engineering. By A. P. M. FLEMING and H. J. BROCKLEHURST. London: A. and C. Black, Ltd. 1925. Price 12s. 6d.

THIS volume is one of a series of Histories of English Industries, which is being published under the general editorship of Mr. E. Lipson, who himself wrote the "History of the English Woollen and Worsted Industries." The value of such histories is not in doubt. Apart altogether from their intellectual value, they have a moral value of their own. In the great days of its rapid industrial development, Great Britain acquired a self-confidence and self-reliance of which the economic results were seen in ever-widening circles of trade and industry. Other nations took umbrage at the conceit of Englishmen, and by this means and that led them to think with diffidence of their abilities. Now we have reached a stage when we have so little confidence in ourselves that a foreign invention is more likely to receive the support of capital and the welcome of manufacturers than one of native growth.

That attitude towards ourselves is very damaging, and because the history of Great Britain's industries cannot fail to do something towards restoring our lost confidence is one reason for the welcome we give it. To Mr. Fleming and Mr. Brocklehurst has been entrusted an industry which in a sense may be regarded as of British origin. Mechanical engineering in its modern sense began with the coming of the steam engine in whose train followed the vast developments that the world has seen in a century and a-half. Civil engineering, to which they devote many chapters, had much earlier origins, but no one can overlook the brilliant part that British engineers have played in its development in all corners of the earth. Electrical engineering began with the researches of Faraday, and owes a great deal to the enterprise of English engineers and adventurers. With regard to the basic industries of steel and metals, we may claim as proud a history as any nation can show.

The authors have done their work with care, and appear to have consulted the latest authorities about their facts. We are rather doubtful that they possess that magic touch which attracts the general reader to subjects outside his common ken, but as a volume for students of industrial history the book has much to commend it.

Electrical Engineers' Data Books. Vols. I., II., and III. London: Ernest Benn, Ltd. Price 15s. per volume.

EACH of these volumes deals with a different branch of electrical engineering, and they are all planned and edited by Mr. E. B. Wedmore, but the actual compilation has been undertaken by various authors. Vol. I., which is the most extensive, is devoted to lighting, traction and power distribution, and contains a vast amount of information in concise form. There are sections on illumination, batteries, power distribution, switchgear, traction, motor control and electrical machinery. This volume also contains a considerable number of useful tables and wiring rules and regulations. A very extensive field is covered, and the book has the merit of being up to date. The compiler is Mr. D. V. Onslow, who is also responsible for Vol. II., which is devoted to manufacture, design and laboratory work, and contains sections on insulation, electrical phenomena, properties of materials, bridge measurements and pyrometers. As in the case of Vol. I., there are also some useful mathematical and other tables. Manufacturers and those engaged in research work should, we think, find this volume useful. Vol. III., which has been compiled by Mr. J. H. Rayner, is devoted to radio engineering. The branches of the subject covered are radio calculations and measurements, tuning and radiation, thermionic valves, transmitters, receiving apparatus, the design of masts and aerials, and various miscellaneous matters, such as modulation and distortion, atmospherics and so forth. As a handbook for radio engineers, the volume is probably one of the best available, and, like the other two volumes, it contains various electrical, mechanical and physical tables.

SHORT NOTICES.

Chemical Engineering Library. By various authors. London: Ernest Benn. 1925. 6s. each.—This series has now extended to fifteen little volumes of from about 150 to 200 pages each, and several more are in preparation. By subdividing the field in this manner and getting a specialist to deal with each division, it has been possible to make each book fairly comprehensive and save the reader the trouble of wading through matter which does not interest him directly, as would be the case if all the information were given in one volume. The books published so far comprise:—"Autoclaves and High-pressure Work," by H. Goodwin; "The Technology of Water," by A. A. Pollitt; "Distillation in Practice," by C. Elliott; "Organisation of Production," by J. W. Curtis; "The Screening and Grading of Materials," by J. E. Lister; "Crushing and Grinding Machinery," by H. Seymour; "Mechanical Mixing Machinery," by L. Carpenter; "The Theory and Practice of Combustion," by J. E. Lister and C. H. Harris; "Agitating, Stirring and Kneading Machinery," by H. Seymour; "Sulphuric Acid Concentration" (two volumes), by P. Parrish and F. C. Snelling; "The Dust Hazard in Industry," by W. E. Gibbs; "Distillation Principles," by G. Elliott; "The Chemistry of Power Plant," by W. M. Miles; and "The Design and Arrangement of Chemical Plant," by G. Weyman. All these books are of a thoroughly practical nature, and although it is inevitable, in view of their comparatively small size, that some aspects of the subjects have to be passed over quickly, they contain much useful information.

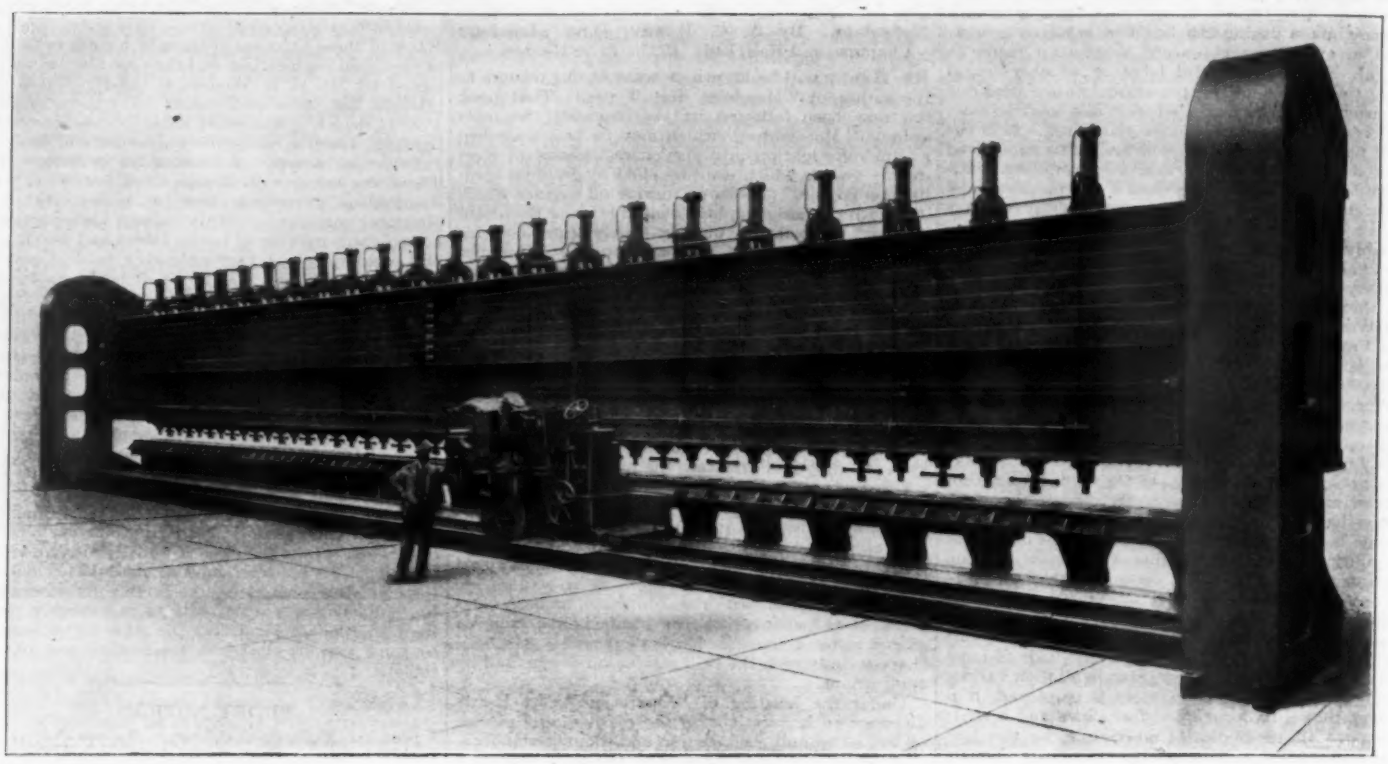
Lubricating Oils, Fats and Greases. By G. H. Hurst. London: Scott, Greenwood and Son. 1925. 12s. 6d.—This is the fourth edition of the work by Mr. Hurst, late Lecturer at the Municipal Technical School, Manchester, which first appeared in 1896; it has, however, been revised and enlarged by Mr. H. B. Stocks. It is an eminently practical book dealing with the subject right through from the winning of the raw materials to the production of the refined oil. The characteristics of all kinds of oils, mineral, animal and vegetable, are given, and the most appropriate lubricants for various purposes are specified. There is a long chapter on friction, and others dealing with the lubrication of internal combustion engines and electrical commutators. The analysis and testing of oils are explained at some length.

Technical Plumbing and Sanitary Science. By S. B. Bennett. London: B. T. Bataford. 9s. 6d.—Household plumbing can hardly be classed as engineering, but there are occasions, especially abroad, when an engineer has to turn his hand to such affairs, and plumbing is an art known to few. Then a book of instruction would prove very useful. Mr. Bennett's work contains a lot of information, unfortunately arranged in a very haphazard fashion, dealing with general principles, which might help on such an occasion, but although he is obviously a practical man, he gives no help to the inexperienced in such matters as the wiping of a joint or the connection of a drain pipe to an earthenware sink, this volume, as the name implies, being intended for the true plumber.

Principles of Machine Design. By C. A. Norman. New York: The Macmillan Company. 1925. 28s.—This book is designed much on the same lines as our old friend "Lineham," but is naturally modelled on American practice. The title is, perhaps, not very well chosen, as the work does not contain such a great deal of direct instruction on the process of designing, but there is a great fund of information concerning modern practice to guide the inexperienced. In common with many other American books, some of the illustrations savour rather of the manufacturer's catalogue, but they are, generally speaking, to the point.

66FT. PLATE EDGE PLANING MACHINE

SMITH BROTHERS AND CO., LTD., GLASGOW, ENGINEERS



A Large Plate Edge Planing Machine.

THE unusually large plate edge planing machine illustrated herewith, has been built by Smith Brothers and Co. (Glasgow), Ltd., Kinning Park, Glasgow, to the order of Dorman, Long and Co., Ltd., for use in connection with the Sydney bridge contract.

The machine is designed to plane the edges of high tensile steel plates up to 66ft. long by 2½in. thick. A direct-coupled motor provides the drive. The chief feature of novelty claimed for the machine is the simplicity of the control and the rack drive. The motor is of 40 brake horse power, at 480 revolutions per minute, and is fixed to the saddle which carries the tool, as also is the stop and start switch. Attached to the saddle is a platform from which the operator can start up, stop, and reverse the motor in either direction. Also, within easy reach are the hand wheels for the vertical and horizontal feeds, and a hand lever for tilting the tool-box, so that the operator has full control of the machine without having to leave the platform. Contactor gear forms the motor control. The master switch is fitted inside one of the large housings at the end of the machine, and is operated through a kicker bar—to be seen in our engraving at the front of the bed—by a foot lever on the saddle platform. The tool has two cutting edges, and is carried in a box which is tilted by hand horizontally at each end of the plate, through the angle of relief, so that the tool can cut on the forward as well as on the backward stroke.

For holding the plate down on the table 22 hydraulic cylinders are provided on the top side of the built steel girder. This girder is 7ft. 2in. deep, and is jointed in the middle. In addition to the hydraulic cylinders, 21 hand screws are fitted to the under side of the beam alternately with the cylinders, but these screws are only used when water is not available. Current to the motor is supplied from wires running along the top front side of the girder with which roller collectors make contact. The motor drives through three trains of gear wheels on to a large pinion which meshes with a rack fixed to the underside and running practically the full length of the table. All the gearing, including the rack, are made of steel, the teeth being machine cut from the solid. Change gearing is provided to give two cutting speeds, namely, 25ft. and 40ft. per minute. The machine is arranged in such a way that, in the event of the trip gear failing to operate properly or of a failure in the current supply when the saddle is nearing one of the housings, there is no danger of a smash, as a result of overrun. The saddle in these circumstances would simply travel on until it left the rack and came to rest about 2in. short of the housing.

Each housing is 24in. deep, and the overall length of the machine is 78ft. 10in. The motor traversing the saddle is larger than is necessary, but the size adopted was chosen for the sake of standardisation and interchangeability purposes. We understand that Messrs. Dorman, Long and Co.'s representatives who witnessed the test of the machine at the makers' works were very pleased with the results. The tool was fed downwards, and cuts ¾in. deep by ¼in. feed, were, we are informed, easily carried continuously at a cutting speed of 40ft. per minute. For the same contract, Smith Brothers and Co., Ltd., recently shipped to Sydney a large single-ended machine with adjustable centres for bending and straightening rolled steel H beams measuring up to 24in. by 7½in. and 100 lb. in section.

TRIALS are to be made on the Southern Railway with concrete sleepers formed as two blocks, 24in. by 7in., tied together by a steel rod.

A Portable Asphalt Plant.

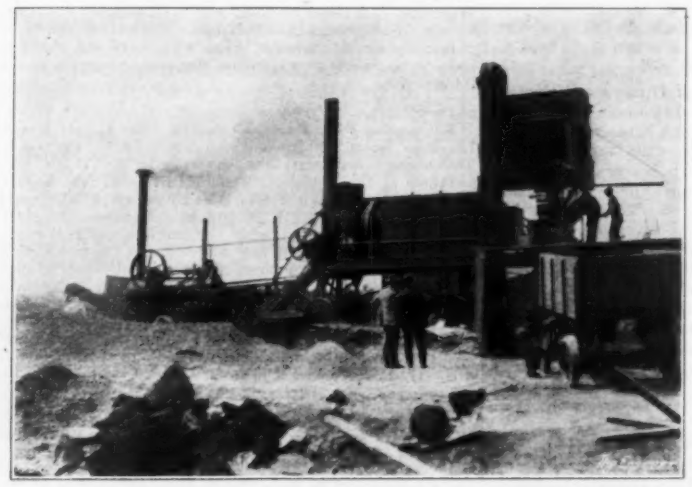
THE half-tone engravings which we reproduce below represent an asphalt, or bituminous macadam, mixing plant, by Marshall, Sons and Co., of Gainsborough, which has been at work on a road-making contract in Ireland for some time past.

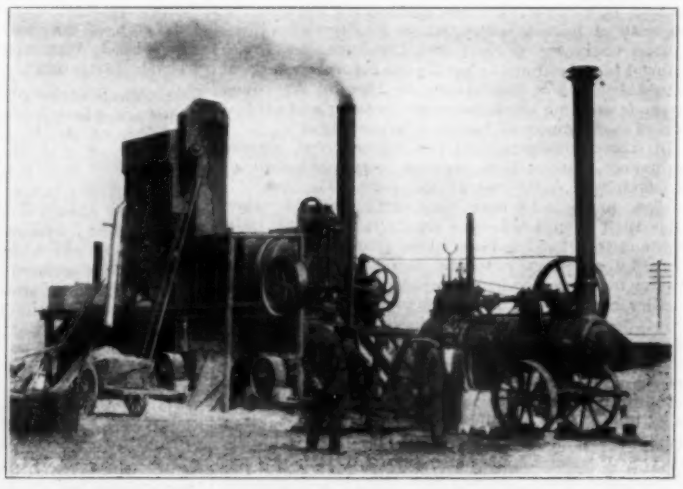
These plants are of the American Cummer design, but are entirely British made. One of their chief features is their ready portability. As will be seen from the illustrations, the whole machine is mounted on a set of wheels, one pair of which is on a pivoted axle, so that it can be steered round corners. When the machine is travelling, some of the top hamper is, however, dismantled, and it will then pass under most ordinary bridges.

The drying drum is, of course, the all-important part of an asphalt plant, and in the Cummer design it is heated externally. It has a series of openings, or ports, in addition to the large opening at the rear end. The hot gases are drawn in through these openings, so that they are directly effective in drying the material. The interior of the drum is fitted with a series of longitudinal angle bars, which cascade the material over and over as it rotates, and the drum is set at a slight angle, so that the stone is fed forward to the outlet by gravity.

The drum is supported at one end by a large gun-metal bearing, and at the other by a pair of steel rollers, which run on adjustable gun-metal bearings. It is surrounded by a steel casing lined with fire-brick, and directly beneath it there is the furnace, the gases from which are drawn through the drum by a fan and discharged up the square stack shown in the engravings.

The aggregate is lifted up to the dryer by a bucket elevator, and is guided into the opening of the drum by a shoot, which is so formed that there is no risk of choking.





MARSHALL'S 8-TON PORTABLE ASPHALT OR BITUMINOUS MACADAM MIXING PLANT

In the case of the 8-ton plant, under review, the elevator is it will be seen, arranged at the end of the machine. On the 4 and 12-ton models it is placed at the side, and in the case of the 18-ton size there are two elevators. The hot, dry aggregate coming from the drum drops down into the boot of another elevator, which raises it to a rotary screen above. This elevator is totally enclosed, with the object of conserving heat as far as possible and to prevent dust blowing about the plant. The screen also is totally enclosed, and is arranged immediately over a large storage bin. This bin is partitioned off to separate the different sizes of material, and is large enough to contain one hour's supply of aggregate, so that it helps in equalising the temperatures of the aggregates. A by-pass is arranged round the screen, to allow the material to be sent directly to the bin when it is not necessary to screen it, and there is a shoot for discharging over-sized stone to a cart alongside.

Below the storage bin there is a weighing box, hung on an adjustable scale. The scale has several beams, so that the materials can be weighed separately or collectively. There is a separate scale for the bitumen bucket, which is hung from a trolley running on an overhead rail.

The mixer is placed directly under the discharge door of the weighing box, and is of the pugmill paddle type. It has two gear-driven shafts, which rotate in opposite directions at a moderately high speed, and on these shafts there is mounted a series of manganese steel teeth. The shaft bearings have dust-proof housings. The body of the mixer is fitted with renewable wearing plates, and in some of the plants it is also steam jacketed. The mixture is discharged through a door in the bottom of the casing, which slides on rollers that can be adjusted to make a good joint and yet allow the door to slide easily.

The bitumen is supplied to the weighing bucket by means of a pump driven off the transmission gear of the main plant. This pump sucks the melted bitumen from the boiler, through a strainer, and delivers it to a two-way valve over the bucket. From this valve there is a return pipe leading back to the boiler. With this arrangement, it is possible to keep the bitumen circulating round the system, so that the pipes do not get clogged up, and to have a supply of hot bitumen always available at the two-way cock. When the plant is shut down the pump is reversed, and the piping cleared of bitumen. The piping is also so coupled up that it can be easily taken adrift for clearing if it should accidentally become choked.

When these mixing plants are at work they are jacked up to the height necessary to permit a wagon to be run under the discharge door of the mixer, and chocks are fixed under the wheels to steady the whole plant. For transport to a new site of operations, the machine is lowered on the jacks to bring the wheels down to ground level. The rotary screen and the upper part of the storage bin are removed, and the hot elevator is lowered. In the case of the larger plants the elevator is hinged, and it is swung back on the top of the dryer casing, but in the small 4-ton machine the elevator is pivoted at its centre, so as to enable it to be swung from the vertical operating position into a horizontal attitude without further dismantling. The screen casing also is so contrived that it can be quickly lowered on to permanent skids provided for the purpose. In this condition the total height of the plant above ground level is 13ft. 8in. The total weight of the plant, ready for the road, is 15 tons, in the case of the set with an output of 4 tons per hour, 20 tons for the 8 tons per hour set, and 24 tons for the 12-ton set. The powers required to drive them when at work are 15, 25 and 40 brake horse-power respectively.

Plain *v.* Roller Bearings for Tramcars.

AN interesting series of comparative tests of tramcars, with the axles and motors fitted with plain and roller bearings respectively, has been carried out by the Engineering Department of the National Physical Laboratory for the Hoffmann Manufacturing Company, Ltd. The tests were carried out by the permission and with the assistance of Mr. P. Priestly, A.M.I.E.E., general manager of the Liverpool Corporation Tramways, which are the owners of the cars used. The roller bearing car was of special design, having radial axles and improved suspension, special brakes and a 10ft. wheel base; it is noteworthy that the thrust as well as the journal load in the axle-boxes was supported by anti-friction bearings. The plain bearing car was of the standard wide wing type with a 7ft. 6in. wheel base. The roller bearing car was 1 ton heavier than the plain bearing car, the respective weights under half load being 32,890 lb. and 30,650 lb.

The tests carried out consisted of (1) tractive resistance, (2) coasting, (3) determination of starting effort, (4) electrical consumption, (5) acceleration.

Tests 1 and 2 were conducted on both cars during the same night, on the same track, and under exactly similar conditions. Test No. 3 for the starting effort was made in a tramcar depôt, and the consumption tests were made on each vehicle in turn, extending over eight days of service running.

Tractive Resistance Tests.—These tests were made in both directions on the most convenient length of track of low gradient which was available, and mean figures are given. The track was a straight length of sleeper track of 1 in 500 gradient, and one-eighth of a mile long. It was approached at one end by a gradient of 1 in 238, and at the other end by a gradient of 1 in 205, both gradients being in the same direction as the test length. The tests were made at half-load, the added weight being equal to that of thirty-six passengers of average weight of 140 lb. The tractive resistances for the two cars at the average actual speed obtaining during the electrical consumption tests were 510 lb. for the plain bearing car and 310 lb. for the car fitted with roller bearings, giving a reduction in favour of the latter of 39·2 per cent. The maximum percentage reduction in favour of the roller bearing car was 54·2 at 2 miles per hour, and the minimum reduction 26·8 at 16 miles per hour.

Starting Effort.—The determination of the initial efforts required to set the vehicles in motion was made by means of a draw-bar dynamometer. The cylinder of the latter was attached to the car under test and connected by means of a block and rope tackle to a second car which was securely braked. The tension of the free end of the rope was increased gradually until the test car just began to move, and the record was taken on the apparatus inside the car. The tests were carried out in a car shed in which the rails were on a slight incline, and consequently they were made in both directions, up and down the gradient, and the means of the results determined. The values given are the means of ten pulls in each direction. The tests were made at half-load and the average values obtained were 820 lb. for the plain bearing car and 350 lb. for the roller bearing car. The values of the starting effort are given in the diagram Fig. 1. These values are considered to be on the high side, owing to the state of the rails, which, in spite of cleansing by watering and brushing prior to the tests, were in a bad condition, being rusted and coated with sand which had been rolled into the tread.

Coasting Tests.—These tests were made on the same

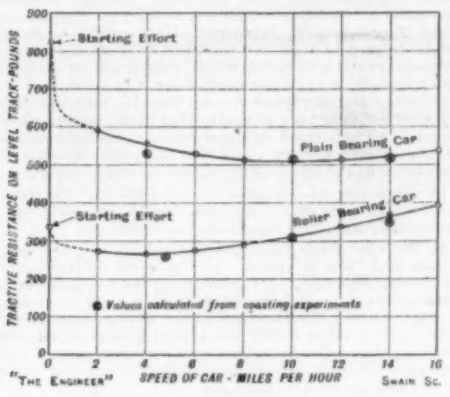


FIG. 1

track used for the tests of tractive resistance and were made in the uphill direction only, as in the short length available the loss of speed of the roller bearing car downhill was inappreciable. The car was started some distance beyond the beginning of the test length and the power was cut off at high speed as soon as the test track was reached. The loss of speed up the gradient and coasting was obtained by measuring increments of distance travelled and increments of time over the test length. These increments were plotted on the record paper by a castor wheel and clock behind the car. Fig. 2 shows the rate of reduction of speed with time for the two cars. It will be observed that, owing possibly to the lateral oscillations of the plain bearing car, the curve for this at the higher speeds is erratic. The average value of the retardation taken from the curves of Fig. 2 at a speed of 10 miles per hour—14·7ft. per second—was 0·360ft. per second per second in the case of the roller bearing car and 0·593ft. per second per second for the plain bearing car.

Acceleration Tests.—These tests were made on the test track of 1 in 500 gradient previously mentioned. The test car was started up the gradient at as high a speed as possible consistent with safety, and increments of time and distance travelled were recorded. For this purpose the record paper was run at as high a speed as possible. The results

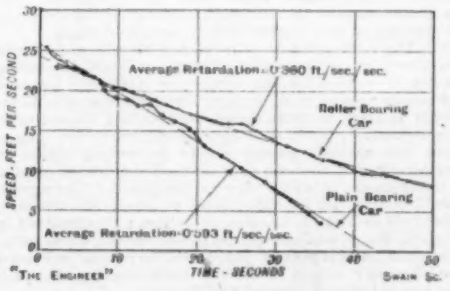
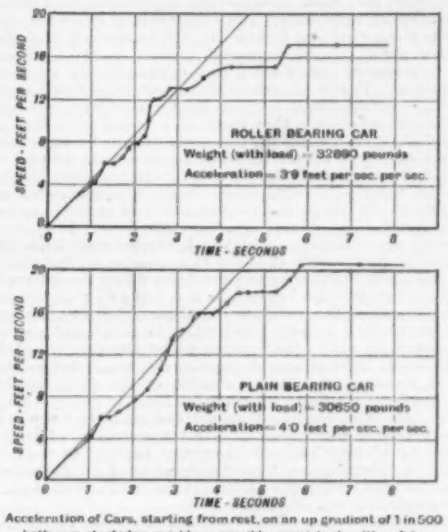


FIG. 2

of the tests are shown in Fig. 3, from which it will be noted that velocity-time curves exhibit almost identically the same characteristics. They show the effect of the change-over from "series" to "parallel" control, and both indicate that a slight readjustment of the resistances controlled by the later notches of the starter would tend to give a smoother starting period. The mean acceleration shown was 4·0ft. per second per second for the plain bearing car and 3·9ft. per second per second for the roller bearing car, but it should be remembered that the weight of the roller bearing car exceeded that of the plain bearing car by 1 ton, and also that the value of the acceleration obtained depends in a considerable degree on the time taken in moving over the controller handle.

Power Consumption.—The route selected for the tests of power consumption by the general manager of the Corporation tramways was a representative service route and included some of the busiest streets besides a substantial length of sleeper track. On account of the shortness of the route—6·355 miles—it was considered desirable to traverse the route four times daily in each direction for four days with each car. The weather was fine throughout the series of tests, with very little side wind, and the traffic conditions were practically identical for each car. The same driver was employed for all the tests. The route was divided into six sections, and during the tests the cars were stopped at all the stations dividing the sections from one another, at all intermediate "Board of Trade" stations, and otherwise only when necessary for traffic conditions. A record was kept of the consumption of electrical energy over each section and also the time taken and the number and duration of the stops. The object of the time measurements was to show that the actual time of running was on the average approximately the same for both cars. The consumption per car mile for the plain bearing car averaged over the whole distance run, namely, 203·4 miles, was 2·161 units, and that of the roller bearing car 1·649 units, the average saving of the latter being, therefore, 23·7 per cent. The mean service speed over the whole distance was greater in the case of the roller bearing


SPEED - FEET PER SECOND
ROLLER BEARING CAR
Weight (with load) - 32890 pounds
Acceleration - 3·9 feet per sec. per sec.
TIME - SECONDS
SPEED - FEET PER SECOND
PLAIN BEARING CAR
Weight (with load) - 30650 pounds
Acceleration - 4·0 feet per sec. per sec.
TIME - SECONDS

Acceleration of Cars, starting from rest, on an up gradient of 1 in 500 both cars started as quickly as possible, consistent with safety.
"THE ENGINEER" SWAIN Sc.

FIG. 3

car by about 0·9 per cent., and the mean actual speed was also greater for the same car by 0·2 per cent. These figures show how nearly identical were the conditions under which the tests of the two cars were carried out.

Durban Water Supply.

AT the annual congress of the African Section of the Institution of Municipal and County Engineers, which was held at Durban in July last, Mr. W. M. Campbell, M. Inst. C.E., the borough water engineer, delivered an address on the water supply system under his control, which included an interesting account of the Shongweni works. In 1921, it appears that the Durban Corporation secured powers to carry out the Shongweni water scheme, which is now in course of construction, and is estimated to cost £750,000, including the purchase of land and engineering charges.

The scheme, in the main, consists of a storage reservoir on the Umlaas River, known as the Vernon Hooper dam, an aqueduct consisting of covered conduits, tunnels, syphons and trunk mains of an aggregate length of approximately 20 miles, and the necessary sedimentation and purification works. The construction of the Vernon Hooper dam was begun in March, 1923, and is due for completion in September, 1926. The dam is situated about 25 miles downstream of the existing Camperdown dam—which, with the Clear Water dam gives storage facilities amounting to only 295 million gallons—immediately below the confluence of two tributaries of the Umlaas River, viz., the Sterk Spruit and the Ugede Stream. The capacity of the reservoir will be some 2600 million gallons. The dam is a mass concrete structure, extending across the valley straight on plan, having a maximum base width of 70ft. and crest width of 8ft. The total length of the dam at parapet level will be 808ft. Full supply level will be 987.75ft. above sea level, and the maximum depth of the impounded water will be 87.75ft. The material of the structure consists of 8 : 4 : 1 concrete in the mass encased in 4 : 2 : 1 concrete on the upstream side and 6 : 3 : 1 on the downstream side, and although originally a concrete block facing was contemplated, it was eventually decided that a more homogeneous result would be obtained by self-faced concrete work.

The original design has also been modified in other important respects, more particularly with regard to the proposed installation of a number of undersluices, 10ft. above river-bed level, for the purpose of preventing silt deposits. Silting, it may be mentioned, has given much trouble at the Camperdown works, and in twenty-three years the loss of capacity has amounted to no less than 68.5 per cent. of the original capacity. Much of the silt is of an argillaceous nature, and irremovable by any practical expedient. In the present case, actual experience of the river behaviour during the past few years, together with a study of the rainfall incidence has indicated that it is only at intervals of from six to eight years that scouring floods are available, and as the scouring path of such occasional and short-lived floods must be confined to a river channel of relatively narrow width, the remote possibility of removing deposited argillaceous silt for any appreciable valley width would not have justified the heavy expenditure that would have been entailed in the providing and erecting of the large undersluices proposed.

An alternative proposal was fortunately available, which, although more costly, presented a more absolute method of dealing with silt. Briefly, this proposal consists of erecting a diversion weir near the upstream end of the reservoir, and providing a canal big enough to deal with the smaller floods which naturally are in the great majority. This canal will have a capacity of 1000 cusecs, and will be led downstream to join a large tunnel which passes through the flanking range constituting the right abutment of the Vernon Hooper dam. The tunnel will be of ample capacity to deal with floods up to 8000 cusecs, and will be carried through from 20ft. above river-bed level at a point some

1000 yards upstream of the dam to a point 100 yards downstream of the dam. Control at the reservoir portal of this tunnel will be by a vertical sliding gate.

The manipulation of these arrangements in average years may be anticipated as follows:—The smaller floods which occur in the early part of the rainy season and seldom exceed 1000 cusecs, will be passed downstream without entering the reservoir, thus not only precluding the unburdening of their silt content in the still water of the reservoir, but, what is of no less importance, preventing the already impounded, and consequently clearer water, from being rendered turbid. It will be realised that this latter phase has an important bearing on the economy of subsequent coagulation and sedimentation prior to filtration. Floods of greater magnitude than 1000 cusecs will, of course, have to pass their excess flow into the reservoir, and when that stage of seasonal river flow is reached, it will generally be quite politic to bring the flood diversion tunnel into operation, which, except in most abnormal conditions, will deal with the larger floods.

The flood of 1925, which reached a maximum of about 10,000 cusecs, and maintained flood proportions for one month, was followed by an average flow of 190 cusecs during about three months, which carried very little silt after the first onrush of about three weeks, so that there was ample water flowing to provide for filling the reservoir with selected water before the flow fell away to normal winter proportions. Floods in excess of 8000 cusecs are of very rare occurrence, and when in movement are so turbulent in action that except where the coarser silt is concerned, little serious deposition can result before the flood diversion tunnel can dispose of the then rapidly decreasing flow. With the diversion canal in full operation during the rainy months, there will at least be just so much less silt-laden water passing into the reservoir, which its capacity of 1000 cusecs will convey past it, so that in years of relatively low flow the quantity of silt deposited may be kept within the narrowest limits of selection that the conditions will afford.

In the dam the several outlets will consist of (1) the supply valve tower provided with three sluice valves at the 12ft., 42ft. and 72ft. levels above the river bed, so that effective decanting may be ensured. These valves will be worked hydraulically. (2) An undersluice of the needle valve type passing through the dam 10ft. above river bed level, which will provide for rapid emptying of the dam when required. (3) A 30in. outlet and three 36in. outlets at river-bed level, primarily intended for dealing with water during construction, but which will serve as emergency outlets when required. The combined capacity of all these dam outlets will be about 2000 cusecs. A length of syphonic spillway is also provided with a discharging capacity of 7800 cusecs. The maximum discharge allowed for is 27,000 cusecs, which was the ascertained peak discharge during the flood of October, 1917, and is equivalent to practically 0.135in. run-off per hour over the catchment area of 310 square miles. The maximum spillway discharge with the flood diversion tunnel, undersluices, emergency outlets and syphon in operation will entail a depth of 4ft. 6in. on the spillway, but provision has been made for a total depth of 7ft.

For the purpose of access across the river during floods and in order to manipulate the several valves, a longitudinal gallery is being formed in the dam. A water cushion will be formed below the dam by the building of a 14ft. wall across the river, 100ft. downstream. The depth of water impounded there will be 10ft. 6in., and where necessary the rock will be covered with a protecting coat of concrete. Vernon Hooper dam is being provided with expansion joints of similar design to those introduced into the Calitzdorp dam, Cape Province. In order to clear the water during flood periods by coagulation, provision is being made immediately below the dam for the construction of sedimentation basins of sufficient capacity to provide for continuous settlement of 20 million gallons per day passing through these basins, with a horizontal velocity of about 1.35ft. per minute.

At a distance of about 2620ft. from the dam and after sedimentation the water passes into tunnel No. 1, 7604ft. long, and capable of conveying with a water depth of 4ft. over 25 million gallons per day. One vertical shaft, 187ft. deep, is provided. At the outlet end is a duplicated inverted syphon of 30in. steel pipes, 461ft. long, which passes through a deep valley to conduit No. 1, which is 2907ft. long, with the same internal dimensions as the tunnels. A duplicated inverted syphon, 30in. in diameter, connects the outlet end of the conduit with tunnel No. 2, which is 5984ft. long. Both tunnels are in quartzitic sandstone. No. 2 tunnel is provided with a shaft, 271ft. deep. Conduit No. 2 has a length of 1404ft. A 30in. pipe will be led from the end for a distance of 13,951ft. to the junction with the next conduit, near Mariannhill station. This pipe line will eventually be duplicated, when required. Conduit No. 3 was excavated in open cut through water-bearing sand, almost approaching quicksand in character, and was reinforced with steel rails and rods throughout the whole of its length of 1300ft., until rock was eventually reached, when tunnelling was reverted to. Tunnel No. 3 is 1357ft. long and passes under the new railway deviation through soft sandstone. At the outlet end of this tunnel a pipe line, 27in. diameter, extending for a distance of 21,018ft., will convey the water to Northdene. Tunnel No. 4, which will be in soft ground, will pass under the railway, and will have a length of 231ft. In order to retain maximum delivery head at Northdene, the 27in. diameter pipe will be laid through tunnel No. 4.

World Power Conference, 1926.

THE technical programme of the sectional meeting of the World Power Conference, which is to be held in Basle, at the International Exhibition for Inland Navigation and Utilisation of Hydraulic Power between August 31st and September 12th, 1926, runs as follows:—

A. *Utilisation of Water Power and Inland Navigation.*—(*a*) General, *e.g.*, water flow and amount of deposit in rivers as a function of the time, influence of river and lake regulation and dams on the water flow, &c. (*b*) Technical details: Utilisation of water power—(1) Civil engineering: work above and below ground; (2) hydraulic machinery and accessories; (3) electrical machinery and accessories; (4) switchgear. Inland navigation—(1) Civil engineering: work above and below ground; (2) boats, barges, tugs, &c.; (3) equipment. (*c*) Economic considerations, *e.g.*, cost of producing energy in relation to the size of the installation, &c., transport costs and transport times in comparison with other methods of transport. (*d*) The relationship between water power utilisation and inland navigation.

B. *Exchange of Electrical Energy between Countries.*—(*a*) General particulars as to existing and projected exchange possibilities and their advantages and disadvantages. (*b*) The influence of factors which make the exchange of electrical energy difficult—(1) national and international law; (2) import or export duties on electrical energy when crossing national frontiers; (3) legal questions regarding exchange of energy. (*c*) Influence of the exchange of energy on the running of electric power stations and on the cost of production of electrical energy.

C. *The Economic Relation between Electrical Energy produced Hydraulically and Electrical Energy produced Thermally; Conditions under which the Two Systems can Work Together with Advantage.*—This question should not be treated in a general way, but only on the basis of concrete examples—installations completed or projects which have been carefully worked out. In order that the conclusions of the various reports may be compared with one another, it is very desirable that those factors which have had an important influence on the conclusions should be mentioned separately, and that the prices which have been taken as the basis of comparison should be given.

D. *Electricity in Agriculture.*—(*a*) General. (*b*) Technical descriptions of the various possible applications of electrical energy. (*c*) Economic considerations.

E. *Railway Electrification.*—(*a*) General, *e.g.*, choice of system and basis of choice. (*b*) Technical descriptions—(1) Power stations; (2) converting and transforming stations—so far as they differ from general electricity supply systems; (3) line equipment; (4) locomotives and equipment of other rolling stock used in connection with electrification. (*c*) Economic aspects, with special consideration of those advantages of electric traction which cannot be expressed numerically.

(1) All papers will be printed in Switzerland under the supervision of the Swiss National Committee of the World Power Conference, and advance copies will be available for the participants before the Conference opens. It is intended that the papers, together with the discussions thereon, shall be published after the Conference by the Swiss National Committee in a special volume to be entitled "Transactions of the World Power Conference, Sectional Meeting, Basle, 1926."

(2) Distinction is made between—(*a*) Papers contributed by authors in the different countries by request or on the initiative of the respective National Committees or of a member of the International Executive Council, World Power Conference—"National Papers." (*b*) Papers prepared by general reporters appointed by the Swiss National Committee, containing a summary of all the national papers presented before April 1st, 1926, under the respective headings of the technical programme—"Reporters' Papers. The reporters' papers will also point out those aspects of the subjects to which it is felt the discussions at the Conference should be directed.

(3) National papers will be accepted for presentation to the Conference only when forwarded by a National Committee or by a member of the International Executive Council, World Power Conference.

(4) Each country shall present only one national paper under each of the items A to E of the technical programme. These national papers may be prepared by one or several authors. Any single paper may cover all the subdivisions of any of the five main headings of the technical programme or may deal with only certain of them.

(5) The national papers presented should not exceed thirty-two pages of about 400 words each, including clichés, if written by one author, or sixty-four pages if written by two or more authors. The space available for clichés is 1000 or 2000 square centimetres respectively. The reporters' papers will not exceed thirty-two pages.

(6) The national papers should be written either in English, French, German or Italian. They will be printed in the language in which they are presented. The reports should contain an English *résumé* of about 500 words, if submitted in French, German or Italian; if submitted in English, the *résumé* should be in one of the three other languages. The reporters' papers will be printed in French and German; it will be decided later whether they will also be published in English and Italian.

(7) The papers shall not contain any matter which could be considered to be of an advertising nature.

All correspondence from British participants should be addressed to the secretary, World Power Conference, 36, Kingsway, W.C. 2.

SIXTY YEARS AGO.

IT is sixty years ago since the first Fairlie locomotive engine was constructed. In our issue of December 22nd, 1865, we described the engine, gave some account of its first trial trip, and discussed the reasons for its peculiar design. This form of engine was the invention of Mr. Robert Francis Fairlie, of London, and, as is well known, was characterised by the employment of a double boiler with a common fire-box at the centre of its length. The fireman stood at one side of the fire-box and the driver at the other. Originally it was intended that the products of combustion should be led back from each end to unite in a smoke-box provided with a chimney situated over the fire-box. As constructed, however, the plan, now familiar to us, of employing a separate chimney at each end, was adopted. The engine was carried on two four-wheeled bogies, each fitted with a pair of 15in. by 22in. cylinders, which received their supply of steam through flexible coiled copper pipes. The object of the design was to render the weight of coal and water carried on the engine available for increasing the adhesion of the driving wheels without the restriction imposed on the amount of coal and water carried in an ordinary tank engine, or without resorting to the expedient of fitting the tender with steam cylinders or coupling its wheels with those of the engine. The first Fairlie engine was built by Cross and Co., of St. Helens, for the Neath and Brecon Railway, and was tested on a section of the old Manchester and Liverpool Railway close to its birthplace. By the account we gave of it, the trial trip at which we were present seems to have been distinguished by some curious features. A few short runs, we said, quickly proved that the engine was in the worst possible condition to undertake a trial trip. Indeed, the makers were unwilling that it should be tested at all in the incomplete condition in which it was at the time. Never, we wrote, had we met valves so badly set. The boiler was greasy and foul inside, and primed copiously on the least provocation. An alteration at a late hour in the design of the regulator led to irregular working. The allowance for the expansion of one of the coupling-rods had been overlooked. The steam gauge was placed on the driver's side, where the fireman could not see it. The fireman was inexperienced, and was, in addition, seriously hampered in his work by a crowd of workmen, who, "availing themselves of the Saturday afternoon, swarmed all over the engine." Yet in spite of these defects and disadvantages the engine clearly demonstrated its capacity. We were fortunate in being able to compare it with a London and North-Western six-coupled goods engine, which on the day of the trial pulled a similar weight of train up the same bank as that on which the Fairlie engine was tested. The two engines had the same weight, 42 tons, but the Fairlie carried 30 lb. less pressure. Yet with its defective valve setting, resulting in a waste of at least 15 per cent. of its power, the Fairlie engine succeeded in pulling its load to the top of the bank, whereas the ordinary engine stuck just before reaching the top. Although the appearance of the Fairlie engine did not please the eye, we were satisfied that the principles on which its inventor had gone to work were correct.

NEW BRITISH ENGINEERING STANDARDS.

BRITISH STANDARD VOLTAGES.

A REVISED edition of the B.E.S.A. publication No. 77, "Standard Voltages for New Systems and Installations," has just been issued. Most engineers are familiar with British standard specification No. 77, which was first published in 1921, and set forth the standard voltages for new systems and installations. In that document two standard low voltages were laid down, namely, 220 volts direct current and 240 volts alternating current. At the time when the matter was first discussed, a great effort was made to standardise one low voltage only for both direct-current and alternating-current circuits, but that was not then practicable. Now, however, after some years' experience and further development in the industry, it has been found possible to reach agreement on the basis of one low voltage. The Electricity Commissioners, the Institution of Electrical Engineers and the large industrial and supply organisations have been consulted, also the local Committee of the B.E.S.A. abroad, where the proposal has met with very general approval. The new document lays down 230 volts direct current and alternating current as the standard low voltage for new systems. Copies of the new specification (No. 77, 1925) may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

EBONITE FOR RADIO RECEPTION.

ABOUT twelve months ago a joint request was made to the B.E.S.A. by the Radio Society of Great Britain and by the Ebonite Manufacturers' Association for a standard specification to be drawn up for ebonite suitable for radio purposes. A committee was immediately set up, and the first subject to be considered was ebonite for panels for receiving sets, as it was felt that there was a very urgent need for standardisation of this grade of ebonite. Many purchasers of so-called ebonite panels have found in the past that almost anything was sold as "ebonite" so long as it was black, and it is therefore anticipated that the new specification will go a long way towards eliminating the doubtful qualities of ebonite from the market. The composition of the standard ebonite is rigidly specified, and adequate mechanical and electrical tests are laid down. A recommended list of sizes and thicknesses of panels is included, and while it is realised that the size and shape of panels will necessarily vary in accordance with variations in the progress of design of receivers, every endeavour has been made to cover all reasonable requirements suggested by the trend of present-day design. By making use of the recommended sizes as far as possible the full benefits of standardisation will accrue to purchaser and manufacturer alike. Copies of this specification (No. 234–1925) may be obtained from the B.E.S.A., Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

AN unusual form of explosion of a vertical boiler at Boscombe is the subject of a recent official report. The uptake tube was completely fractured at the root of the upper flange, and the crown of the fire-box was deflected downwards, so that the upper side of the crown was concave. The uptake, owing to the deflection of the furnace crown, was forced downwards 9in. along with the crown. Through the opening formed at the upper end of the uptake, the contents of the boiler escaped to the atmosphere by way of the hole in the crown of the boiler shell, and also down through the uptake tube into the fire-box, and through the ashpit and the fire-door, which was open. The force of the explosion displaced the boiler about a foot from its original position. The explosion was due to rupture of the uptake tube, owing to circumferential grooving at the root of the upper flange on the steam side, and also to internal corrosion of the tube on the fire side. The grooving extended round the whole circumference of the tube. The internal corrosion at the point of fracture had reduced the average thickness of metal to about $^{3}/_{16}$in., and the grooving extended to a depth of about $\frac{1}{4}$in., thus leaving only a thickness of $^{1}/_{16}$in. of sound metal. The original thickness of the metal was $\frac{5}{16}$in.

Some Applications of Research to Modern Foundry Practice.*

By J. E. FLETCHER, of Dudley, Member.

IN this paper the author seeks to illustrate, in some detail, a few examples of the type of work and method of attack used in applying the results of research to current foundry practice.

(1) *Skin Defects, Shrinkage and Contraction.*—In any investigation into the characteristics of cast iron it must be recognised that the metal is a cast product, often of intricate form and of variable thickness. The vitally important character of the skin of a casting is largely dependent upon the satisfactory qualities of the mould material and of its facing, the physical condition of which is of supreme importance.

The mould surfaces, with those of the metal in contact therewith, must be stressed differentially as the flow of the iron progresses and, if the mould face is fissured, however minutely, the metal when sufficiently fluid may be similarly fissured at its surface, the thin skin being thereby weakened during the contraction period, at a time when the metal has little physical strength.

The difference between two portions of a mould surface, one tightly and the other lightly rammed, by hindering and assisting respectively the flow of the gases liberated during the solidification of the metal, may lead to differences in the rate and amount of contraction and cause skin strain or fissure.

The presence of slag or oxide inclusions in such areas of the mould surface may easily intensify the skin fissure trouble and not infrequently such fissures are seen to start from a slag spot.

A wrongly placed runner gate may result in one portion of a casting contracting more rapidly than another, with the accompaniment of internal stress due to the formation of two types of metal structure, as a result of the different rates of cooling, and the casting may warp in consequence of the differential skin or envelope contractions.

The chemical composition of the liquid metal may be all that is desired, the temperature of casting correct, and the mean analysis of the cold casting such as would be deemed satisfactory; but if the mould is carelessly rammed or vented, badly gated and poured, the casting skin cannot be uniformly perfect nor can the metal structure be homogeneously regular nor the casting be free from internal stresses when cooled.

Obviously the design and form of the casting must play an all-important part, and from the above it will be realised that the technique of the moulder and caster and their judgment are of paramount importance.

A little consideration will show that the mean chemical analysis or micro-examination of isolated spots in the structure are often of little service in discovering the cause of a failure, unless the relationship between the structure of the metal, the design and method of gating, running and feeding of the casting are known.

As the skin of the outer envelope of a casting is generally the starting point for fracture when subjected to tensile or impulsive stresses, the cause of the casting failure may not be revealed by a tensile, transverse or impact test imposed on bars cut from the casting, even when taken from the starting point of the fracture. The micro-examination at such spot may not, and in cast iron rarely does, indicate whether overstrain has taken place, there being little or no elongation of cast iron under the breaking stress.

The presence of graphite in all grey cast iron is, of course, responsible for the general absence of ductility, but the skin ruptures which occur in the plastic range of cooling and cannot be healed by any known heat treatment are generally difficult to trace; hence the history of the casting manufacture must be known when investigating the cause of external and internal defects. The contour of a casting, being related to variations in skin cooling rates, due to the character and temperature of the mould facing sand and to methods of gating, rate of pouring and influenced by differential rates of cooling where the form and thickness of the section varies suddenly, must be taken into consideration.

The foundry metallurgist must therefore be thoroughly acquainted with the practice of moulding and casting. He must possess the practical sense necessary to enable him to visualise the effect of altering the physical character of the mould surface and its mass or of changing the method of gating and pouring the casting on the external and internal portions of the metal mass. Without this practical sense fully developed the metallurgist is often at a loss in his attempts to guide the efforts of the foundryman.

Again, the perfect solidity of a grey iron casting is related to its rate of solidification from the outside to the inside of its thickness and to the efficacy of the feeding of the interior of the section last to freeze. When a thick and thin section join one another in a casting the interior of the thick section will be porous, unless the gases liberated within the metal during its solidification can escape readily to the rising heads from the thinner section. Otherwise the thick section becomes a feeder to the thinner, and the former is left porous because of the loss of metal used for feeding the latter.

Liquid metal under a sufficient pressure head in a riser large enough to remain fluid until the casting is solid obviates this difficulty when the variably thick sections are at the bottom of a deep casting, but when these occur at the top, as cast, the lack of sufficient fluid pressure head, due to the absence of amply deep and massive feeding risers, for example, will lead to sponginess or cavities in the thick sections, often of a serious character.

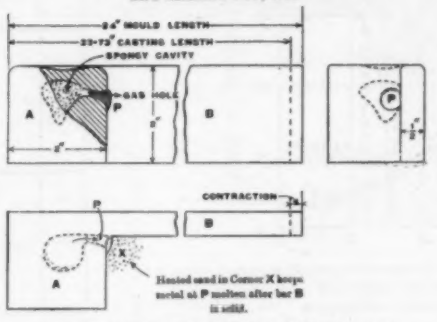
The design of a casting is often such that the temptation to mould and cast the wrong way up is too great, or a pattern may be so made that the same error is followed, through an attempt to cheapen the making of the pattern.

Wherever spongy areas occur in poorly fed thick sections adjacent to thin ones, as in thick bosses in thin plates, there is always a tendency for gas paths to form between the cavity or spongy area and the outside of the casting. The gases pent up in the cavity expand and find a way through the metal generally by way of the corner angle where the thick and thin sections join. The sand in such corners becomes heated to the temperature of the metal and acts as a heat retainer, the metal surrounding the corner being thereby held in the molten state, through which the gas under pressure in the internal cavity escapes to the atmosphere. In Fig. 1 a bar ½in. by 2in. adjoins a metal mass of 2in. cube. The casting was open sand cast, and there being no feeding head over the 2in. thick section a gas cavity formed within this heavy mass. On the freezing over of the top crust the gas liberated during the solidification of the still molten interior attained sufficient pressure to escape by way of a channel communicating with the internal corner between the thin bar and the cube, through the molten metal surrounding the hot sand in the corner, which sand had acted as a heat retainer. The metal was high in phosphorus content and hence contained as a constituent a considerable volume of the carbon-iron-phosphorus eutectic, which is the last constituent to solidify,

FIG. 1.—*Open Sand Cast.*

Analysis of Iron:—Total Carbon 3·62, Silicon 2·26, Phosphorus 1·26, Manganese 0·67, Sulphur 0·09 per cent.

NOTE.—Bars A did not move during solidification of metal. Bar B contracted towards Bars A.



Contraction of Bar Casting showing location of shrinkage defects and extrusion of Eutectic (C Fe P) at P through gas hole communicating with cavity in heavy boss at internal corner.

"THE ENGINEER" SWAN SC.

freezing at about 945 deg. Cent., whilst the main consitutent freezes at about 1145 deg. Cent. The high gas pressure in the cavity had ejected some of the phosphide eutectic through the gas hole formed previously, the bead of eutectic being shown at P in the engraving. The effect of the gas pressure is also seen in the rounded upper surface of the casting. During the solidification of the heavier cube portion the upper crust was seen to rise and then fall immediately after the small gas jets had ceased to blow through the plastic crust, leaving a shrinkage hollow over the cavity.

Had the mould been covered and a riser equal in diameter to that of the cavity been employed the casting would have been sharp cornered, and if the sand in the internal corner had been hard rammed gas escape there would have been avoided. The slow cooling of the metal surrounding the corner would lead to a coarser crystalline structure, rich in graphite and prone to contraction cracks in the skin.

Another point of fundamental importance is shown in the same Fig. 1, and though elementary, when applied to this simple form of casting, is often neglected when more complicated forms are studied. The thin part of the bar contracts towards the heavier end, which remains stationary. Another bar of similar length, with a cube-shaped boss at each end fractured at the internal corners, the thin bar being separated from the two bosses when removed from the mould. When cast on end a similar double-bossed bar fractured at the shoulder under the top boss, the liquid pressure head having prevented the formation of a gas cavity in the lower boss, though there was considerable porosity and shrinkage in the upper one.

The importance of remembering that contraction during cooling is in the direction of the heavier slow cooling masses in a casting is obvious, and often assists a foundryman in deciding on the correct method of moulding, gating, and running a casting.

The influence of sharp internal corners and the effect of the heat retaining sand in promoting porosity and coarse-grained weak metal there, with skin fissures at this weakest spot, is common enough, but the same defects occur even more frequently in cored castings where the cores are much thinner than the wall of metal surrounding them.

In Fig. 2 the progress of volume change and shrinkage in a casting is plotted against the temperature changes as shown by the cooling curve of the metal. The progressive variation in the structural composition of the metal as it cools is also depicted, the whole of the curves being plotted over a time base. Professor T. Turner was the first to show accurately the relation between the volume changes during and after the solidification of cast iron and the shrinkage of the metal. Recent experiments have confirmed his conclusions with respect to the influence of graphite separation near the freezing point, and later, at the pearlite point during the solidification of grey irons.

The structural composition of a grey phosphoric iron, quenched at different temperatures during the cooling from the melting point to about 200 deg. Cent. are also plotted above the cooling curve and time base. Attention should be drawn to the volumetric expansion due to graphite separation immediately following the freezing point, and to a secondary graphite separation at or near the pearlite point (about 700 deg. Cent.). Perhaps the most interesting point recorded in the graphs is the fact that the highest rate of shrinkage of such grey cast iron occurs between the austenite and pearlite points (1050 deg. Cent. and 700 deg. Cent.), in the comparatively short time interval of less than three minutes in the case of 1in. thick material. In thicker metal the cooling rate of the interior is lower, but it is certain that when cooled in a cold mould the skin contraction during the time the metal is above the red heat is very rapid, and in lower silicon iron may readily lead to serious skin fissuring. It would appear from Professor Turner's research and from the author's observations that the greater volumetric expansion of high silicon phosphoric irons, which is not complete until the metal has fallen to below 700 deg. Cent., saves the skin of the castings, though internal unsoundness and porosity may give trouble in castings of variable thickness. The variable rates of cooling at different points within the mass of a grey iron casting containing 3.5 per cent. total carbon, 3.0 per cent. silicon, 1.0 per cent. manganese, and 1.0 per cent. phosphorus are illustrated in Fig. 3. An angle plate section is shown, four points in the corner diagonal being taken for the purpose of indicating the structural changes due to different rates of cooling.

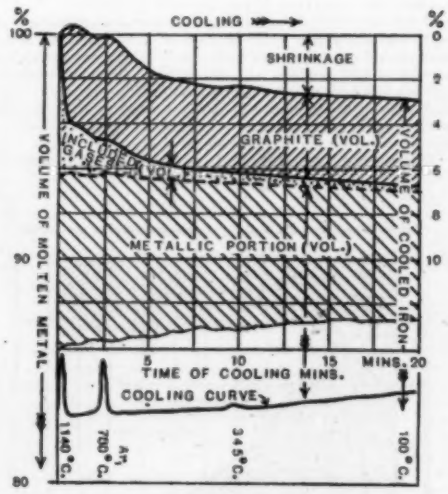
The constituents in the cast iron are given in volume percentages, these values being calculated from the chemical analyses of the metal at the four points in the section. This method of expressing the composition of cast iron in terms of the constituents has been used by the author for some years, but it has only been possible to obtain approximate values for the volume percentages of the constituents until recently, the various specific gravity values being still somewhat uncertain in some cases. The graphs show very clearly the effect of various rates of cooling on the metal structure. Attention is specially directed to the graphite and ferrite volumes in the metal nearest to the internal corner, where slow cooling has resulted in the graphitisation of the carbides originally present in the fluid iron.

In the micro-examination of castings such as the one above mentioned—Fig. 3—the polished and unetched micro-specimens reveal near the edge of the casting the presence of dendritic crystals, the long axes of which are arranged normally to the cooling surfaces or nearly so. These fir-tree-like crystals have their trunks crowded together and their stunted branches dovetail into one another in approximately regular order, enclosing within the interstices between the branches comparatively thin flakes of graphite. The depth or thickness of this columnar or dendritic envelope is greater as the silicon and carbon content decrease. In the centre of the metal mass, where the cooling is slowest, the structure is generally composed (in grey iron) of pearlite, ferrite, and large graphite flakes in confused orientation.

Most, if not all, commercial grey irons are, when cast into thin walled castings, dendritic at the moment of freezing in a cold mould. If more slowly frozen in a thicker-walled casting, the dendrites grow until their original outlines are lost. Unless completely pearlitised (i.e., the

FIG. 2.

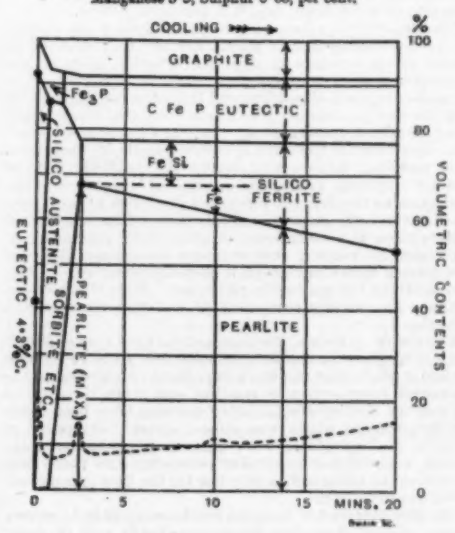
Volume-shrinkage Curves of Grey Cast-iron 1 inch thick. (Typical.)



"THE ENGINEER"

Structural Changes during Cooling of Grey Cast-iron.

Analysis:—Carbon 3·5, Silicon 3·0, Phosphorus 1·0, Manganese 0·5, Sulphur 0·06, per cent.



* The Institution of Mechanical Engineers.

original austenite converted into pearlite) the austenitic dendrites may retain so much of their original iron and manganese carbides that they produce a hard brittle structure which, though high in tensile strength, has little impact-resisting value, the presence of sulphur as sulphides intensifying the trouble.

There seems little doubt that the dendrites are the crystals which grow during the decomposition and graphitisation of the 4.3 per cent. carbon eutectic, which forms the first matrix of all cast irons and is the major constituent to freeze, but is rapidly decomposed in presence of more than, say, 0.5 per cent. silicon.

The structure of any moderately thin-walled iron casting as cast in a sand mould may therefore be conceived to consist of an envelope of dendritic crystals, more or less decomposed or pearlitised, enclosing a core of mixed crystals composed of pearlite and ferrite intermingled with graphite and phosphide eutectic, the silicon and manganese being dissolved in the matrix. In Fig. 4 the type of structure, illustrated in the form of castings made by the author from puddling furnace slag, shows the dendritic form of primary crystals enclosing a core of mixed crystals, analogous to the form of structure produced in most cast irons at the early stage of solidification. This illustration also typifies the variations in gas cavity formation as influenced by varying contours and thicknesses of walls. The defects shown have been repeatedly observed in white iron castings for malleable processes. Here the primary crystals are largely composed of 4.3 per cent. carbon eutectic.

The Trend of Future Developments in Cast Iron.—Metallurgical workers in the field of cast iron have recognised for many years that the most important constituent in the structural composition is pearlite and from the earliest days of the British iron industry castings have been made the structure of which was almost entirely composed of pearlite and graphite, with silicon, phosphorus, manganese, and sulphur in similar percentages to those now recognised as being sufficiently low for the best types of so-called pearlitic iron.

The development of research on this subject in Germany during recent years has been remarkable and of great importance to the cast iron industry. The range of composition covering what may be termed pearlitic irons has been well illustrated by a diagram evolved by Dr. E. Maurer, of Essen, based upon earlier researches by Dr. Guillet on the properties of iron-silicon-carbon alloys. This diagram is shown in the lower part of Fig. 5 and consists of the four inclined lines passing through the point representing the 4.3 per cent. carbon, 0.0 per cent. silicon alloy. Maurer has shown that the pearlitic irons lie within the lines 4.3 per cent. C, 7 per cent. Si, and 4.3 per cent. C, 2 per cent. Si.

In practice the sum of the carbon and silicon contents in pearlitic irons ranges between 4.0 per cent. and 5.2 per cent. The author has therefore drawn lines representing these two ranges through Maurer's diagram cutting the four Maurer lines and enclosing an area shown by the hatched four-sided figure. This area represents very approximately the practical range of pearlitic irons.

Castings made from steel containing, say, 1 per cent. silicon, 1 per cent. manganese, and 0.2 per cent. phosphorus and unannealed would be unlike any cast iron composed of 2 per cent. graphitic carbon, 0.9 per cent. combined carbon, 1 per cent. silicon, 1 per cent. manganese, and 0.2 per cent. phosphorus, although it has often been said that cast iron is simply a steel matrix with graphite as a weakening constituent.

It has been pointed out, however, that molten iron of, say, 3 per cent. carbon content is a mixture of the 4.3 per cent. carbon-iron eutectic and iron, which graphitises during cooling, producing, when cooled at a certain rate, silico-pearlite, graphite and free ferrite. The mechanism of this pearlite production is quite different to that yielded by the ordinary steel making processes, which function in the absence of graphite, for in grey cast iron the pearlite formed is the product of the decomposition of austenite, resulting in a mixture of pearlite and graphite.

It has also been shown that when metal containing 3 per cent. carbon, 1 per cent. silicon, &c., is cast into a cold sand mould (or any other cold mould) the primary crystals at the mould surface are dendritic, enclosing probably and often a core of graphitic pearlite. This dendritic shell contracts at a different rate to the more highly graphitic central mass and, though of greater tensile strength, is brittle, as most dendritic structures are.

If the 3 per cent. carbon, 1 per cent. silicon iron is cast into a hot mould, the dendrites have time to grow, and if the mould is heated to a temperature suitable to the thickness of the casting (higher for thin than for thick castings) and to the silicon and carbon contents, the dendritic structure can be made to disappear and the entire mass becomes homogeneously pearlitic or very approximately so in the various castings so far determined. This method of using sand moulds heated to determined temperatures is due to Diefenthaler and Lanz, and known as the Perlit process. The non-dendritic castings so made, though no higher in tensile strength than ordinary semi-steel castings of similar chemical analysis, possess much higher resistance to repeated impact tests.

If similar cast iron, preferably rather higher in silicon and low in total carbon content, is melted and poured at a higher temperature into a cold or slightly warmed sand mould the heat lost by the metal in cooling from its superheated temperature to the freezing point heats the mould and a similar iron to that of Diefenthaler-Lanz is produced, but, judging from the higher tensile strength obtained, the dendritic structure is not entirely destroyed. The higher casting temperature must bring about a primary dendritic structure which may be difficult to destroy, for, although the mould temperature when freezing begins may be as high as in the Lanz process, the viscosity of the metal may affect the breaking up of the dendritic structure in some cases.

The method of producing a high tensile pearlitic cast iron by means of warming the mould by superheated metal is due to Emmel, of Mulheim-Ruhr. At the moment comparative repeated-impact tests of the Lanz and Emmel irons are not in the author's hands, but such comparisons, when available, should be useful. The microstructure of the pearlite in the two irons is similar and not distinguishable from that in good ordinary pearlitic irons.

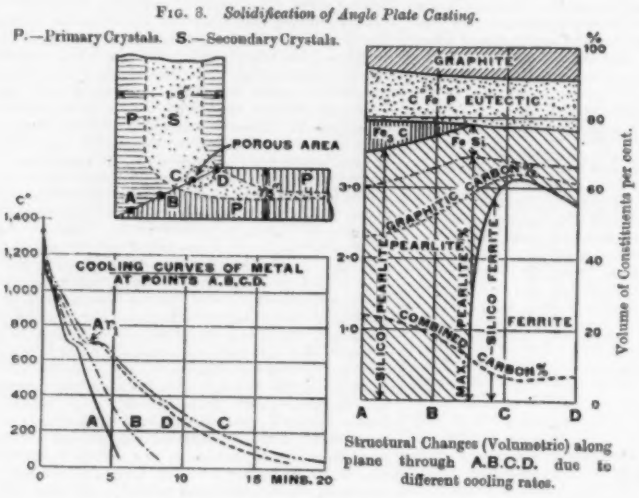
Another German development in the direction of high tensile cast irons is due to E. Schuz, and refers to the production of an iron containing about 3.5 per cent. silicon. This, when cast into metal chill moulds, has a dendritic structure—ferrite crystals being embedded in a eutectic of graphite and iron.

These three methods indicate the trend of foundry practice towards a more scientifically controlled chapter in the history of cast iron founding. British blast-furnace owners are interesting themselves in the production of suitable pig irons for the making of the better cast irons which are evidently coming surely to the front, because of their value to the mechanical engineer. The structural composition of a series of pig irons is shown in Fig. 6. These irons represent the general run of the numbers from white to soft grey as produced in the similar blast-furnaces of a company. When so depicted in graph form the point at which pearlitic irons may be expected is clearly shown. The choice of suitable pig irons for foundry mixtures is of great importance and necessarily forms a subject of investigation by the Research Association.

No mention has been made of other moulding and casting methods, such as the use of permanent and semi-permanent and metal chill moulds, though in this connection the problems of structural composition, shrinkage and contraction are of paramount importance. Such methods are more connected with the mass production of castings, and as many of these processes are being worked under patent licences individual attention to each typical process would take up more time than the author has at his disposal.

It is hoped that the new escalators at Trafalgar Square Station will be ready for service some time in February. The works include a new subway between the station and Cockspur-street, and passengers will be able to pass to and from the west side of the square without having to cross the road at that busy point.

FIG. 3. *Solidification of Angle Plate Casting.*



Structural Changes (Volumetric) along plane through A.B.C.D. due to different cooling rates.

FIG. 4.—*Sections of Castings made in Slag (cast in Sand Mould) from Puddling Furnace, showing influence of thickness of Casting on Crystallization and Gas Escape.*

All Bars were 6 inches long.

G.—Gas Cavities. P.—Primary (Skin) Crystals. S.—Secondary Crystals.

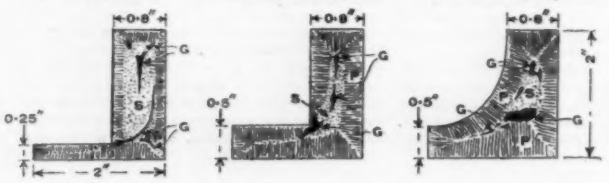


FIG. 5.—*Pearlite in Cast-iron.*

Maurer's Diagram (Fe Si C) with extensions to same.

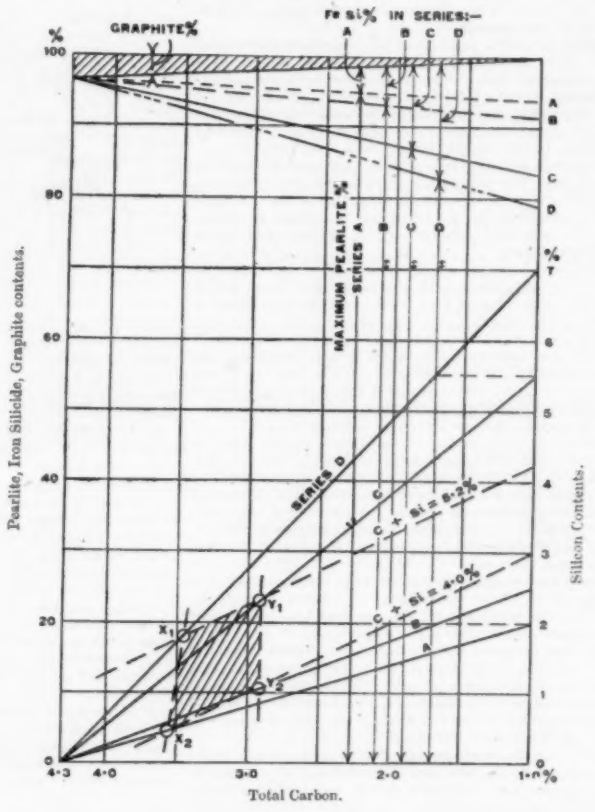
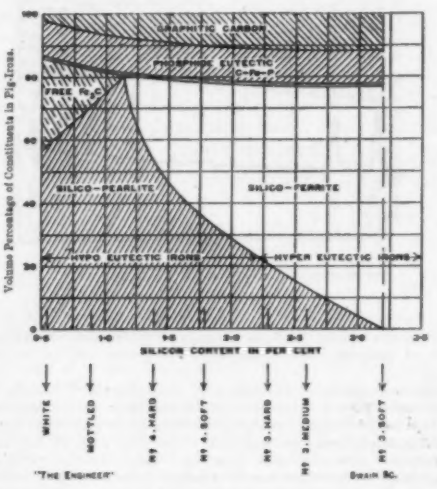

GRAPHITE %
Fe Si % IN SERIES:—
MAXIMUM PEARLITE % SERIES A B C D
SERIES D
C + Si = 5·2%
C + Si = 4·0%
Pearlite, Iron Silicide, Graphite contents.
Silicon Contents.
Total Carbon.

FIG. 6.

Structural Compositions of a Number of Pig-Irons produced in the same Furnace.



South African Engineering Notes.

Durban's Electric Plant.

The Durban Town Council has found that the plant at present installed in its power station will be quite unable to cope with the demand for power until such time as the Electricity Supply Commission's power station at Congella—which is not due for completion until October, 1927—is in operation, even if the demand only increases at its present rate of growth, which has by no means been the case recently, each year having witnessed a steadily rising scale of expansion. The Town Council is now in consultation with the Commission regarding the purchase by the former of another 5000-6000 kilowatt turbo-alternator set, which—along with the first set recently installed—will be ultimately taken over by the Commission at a price to be agreed upon, and installed by the latter in its Congella station. A second 45,000-60,000 lb. boiler plant will also be required, and it is anticipated that this plant, as well as a plant of similar capacity installed at the Municipal Power Station about a year ago, will also be taken over by the Commission. It has therefore been designed for a pressure of 350 lb. per square inch, although the present working pressure at the station is 160 lb.

Industrial Production.

The preliminary result of the 1924 census of industrial production for the Union of South Africa shows that the total value of materials used was £39,327,411; the gross output £79,664,327; and the value added to materials—or the net output—£40,336,916, as compared with £37,139,803, £74,486,292, and £37,346,489, for the previous year, or increases of 5.9, 6.95, and 8.01 per cent. respectively. The net output is only £7000 short of the 1920–21 census, so that allowing for the decrease in prices, it may be taken that in volume the output for 1923–24 establishes a record.

Locomotive Boiler Explodes.

On Tuesday, October 27th, engine No. 1575, while working a goods train, was totally wrecked by explosion of the boiler, when between Vet River and Eensgevonden, in the Orange Free State. The driver was killed outright, and the fireman, Viljoen, succumbed to his injuries while being taken by train to Kroonstad. An eye-witness states that the boiler was thrown 30ft. into the air and turned a somersault, breaking off the smoke-box. It then turned another somersault, landing on the cab side, and fell across the railway fence. The eye-witness, being a native, absolute reliance cannot, perhaps, be placed on his statements. On investigation it was found that a hole had been blown through the top of the fire-box. The boiler and cab were blown off the frame, and the pieces scattered on either side of the track. All the surrounding veld, as well as the frame of the tender and the six trucks immediately behind the engine, were splashed with a mixture of steam and mud. The cause of the explosion is not at present known. There is no question of the engine being overworked or out of repair. It was first put into service in 1914, and went to the repair shop only in August last year, being there for two months undergoing complete overhaul. One theory propounded is that the engine, in drawing up water from the river, which was low, sucked up a considerable quantity of mud, as a result of which the explosion occurred.

Union Coal Production.

There are close on 70 collieries in the Union of South Africa producing coal, and many of them are engaged in converting their surplus stocks into coke, tar, sulphate of ammonia, and other by-products. The total quantity of coal sold between January 1st and August 30th, 1925, was 8,615,456 tons, valued at £2,593,655 at the pit's mouth. These figures, of course, only refer to coal sold, whereas the quantities mined were much greater. For instance, in August 1,305,048 tons were mined, and 1,057,408 tons sold. The total for the eight months is made up as follows: —Transvaal, 3,830,712 tons, £1,219,982; Cape Province, 4,064 tons, £2963; O.F.S., 654,232 tons, £181,637; Natal, 3,126,448 tons, £1,189,073. The approximate respective prices at the pit's mouth were 5s. 1½d. per ton, 14s. 9d. per ton, 5s. 7d. per ton, and 7s. 7d. per ton. The production of by-products goes on progressing, and greater attention is being paid to the latest and best methods. It is stated by the General Mining and Finance Corporation, Ltd., that there is a large area of coal bearing ground in Natal on which it is at present engaged in putting down boreholes with the view of testing the quality and extent of the seams. The results so far obtained have been satisfactory, but more drilling will have to be effected before any decision involving active mining operations can be come to.

Important Plant Addition.

The new turbo-alternator purchased by the Victoria Falls and Transvaal Power Company, Ltd., as an emergency measure, in view of the difficulties being experienced in carrying the constantly growing load on its system, in the interim before the completion of the new power station at Witbank—or at all events a section of it—has now been erected at the company's Rosherville Station, and was started up in a preliminary way on October 7th. It is an English Electric set, which the power company was able to purchase practically ready for shipment, a factor of vital importance. The machine is rated at 12,500 kilowatts, at 3000 revolutions per minute, the turbine being of the pure impulse type. The high speed of the set results in a small compact steam end and a low alternator, and the new unit compares strikingly with the other five 10,000 kilowatt, 1000 revolutions per minute sets installed in the same station. The total installed plant capacity at Rosherville is now 130,000 horse-power. The new machine had hardly been got to work before a fire occurred, which put the whole of the generating machinery in the station temporarily out of commission. At 6.15 on the morning of October 23rd one of the generators was switched on to "load." At first the oil switch, working at a pressure of 40,000 volts, refused to operate, but on the second occasion it blew out and set fire to the oil in the line of tanks in which all the generator switches are immersed. The total quantity of oil ignited was 4000 gallons, the flames spreading from tank to tank. The liquid boiled over from the tanks, and soon the floor of the gallery was covered with boiling oil. Two fire-engines from Johannesburg were soon on the spot, and it was found the only way to deal with the outbreak was to "blast" water on to it at great pressure, and a double line of hose was used to one nozzle to give a stronger jet. After a 3½ hours' fight the firemen had not only extinguished the flames but had prevented them from spreading to the adjoining chambers. Immediately the fire was out an army of workmen set to work to clear up the station. It was about midday when the first generator was put on load again, and by evening a second machine was running, and the remainder of the plant was available for service next morning.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Holidays.

EMPLOYERS and workmen alike in the Midland iron and steel industries have settled down to enjoy to the fullest possible extent the Christmas holidays. It is realised that there is a strenuous time ahead, and the Christmas vacation is welcome as a break from the worries and anxieties which beset all those connected with the basic industries of this country. Though many things have contributed during the past three months to a return of industrial confidence the outlook is still very obscure, and even the optimists who confidently anticipate a revival of business in the New Year are cautious, recollecting how quickly hopes born at Christmas, 1924, died early this year. During the past week there has been very little business transacted in this district, and works were engaged during the first few days in clearing up ready for the stock-taking which follows in most Midland works immediately after the holidays. In a few cases the overhauling of plant has been begun in preparation for anticipated new business.

Market Position.

There was a very small attendance at the weekly meeting of the Midland iron trade in Birmingham to-day —Thursday—and producers and consumers were more inclined to discuss future prospects than to put through business deals. There were not sufficient transactions materially to affect prices, but the expectations of improved buying after the holidays were such as to maintain the general level of prices. Some improvement was reported in Staffordshire iron, a few contracts having been made for delivery next year. This is sufficiently unusual to cause remark, the buying of wrought iron having for a long time been restricted to small lots for immediate requirements. Consumers of pig iron have supplied their wants until January or February, while users of constructional steel are marking time, awaiting New Year developments in the steel trade price war.

Imports and Exports.

The November import and export figures have claimed considerable attention in Midland industrial circles this week, and perhaps it would not be out of place to recall that durng the eleven months of the current year ended November 2nd imports of iron and steel rose to 2,471,482 tons, against 2,207,989 tons last year and 1,214,557 in 1923. This was in a time of restricted trade, when our exports of iron and steel had declined from 3,964,665 tons in the eleven months of 1923 to 3,549,997 tons in 1924 and 3,390,198 tons in 1925. In 1913, when trade was active, and the general volume was substantially greater than it is now, iron and steel imports totalled 2,230,995 tons for the twelve months, some 210,000 tons less than in the eleven months gone by in the present year. Exports in 1913 reached an aggregate of 4,969,224 tons, so that they are now roughly one-fourth less.

Staffordshire Bar Iron.

Wrought iron manufacture in South Staffordshire does not show much vitality, though there have been one or two isolated reports of improved business, a little of which has been on forward account. Makers of high-grade bars are in the best position, but even in this branch there has been little progress despite the lowering of values to £14 per ton. Crown bars continue to be the subject of price shading. They are still quoted £11 10s., but for export some of the Lancashire houses are said to have quoted £11 5s. Staffordshire producers will not go below the £11 10s. level. Nut and bolt makers in this area are a little better employed, but the sale of Staffordshire bars for their production is practically nil, and this in spite of the fact that the delivery of continental supplies is difficult to obtain. Mills re-rolling steel are fairly well occupied. The decision of the Government not to grant the application of the iron and steel trades for the appointment of a committee under the Safeguarding of Industries Act will no doubt be favourably received by the Staffordshire re-rollers, who derived a large proportion of their ingots, blooms, billets and slabs, sheet bars and tin-plate bars from foreign producers in the days before the war. Since that time their reliance on the imported article has been accentuated by the wider difference in the cost of the home and the foreign production, until to-day very little native raw material is used in the local re-rolling mills. Were it not for the re-rolling of this foreign material most of the Staffordshire mills would be completely idle.

Pig Iron.

Midland blast-furnaces continue to find a market for their output, and the position as far as foundry sorts is concerned is considered satisfactory. The brisk sales of this grade of pig effected in October provided smelters with outlets for a large part of their production into the New Year. There is very little disposition on the part of consumers to increase their commitments, nor are furnacemen anxious to pledge much more of their forward output, the uncertainty as to the future price of coke being a deterrent. Smelters hold the view that prices are not likely to go lower, and that they may rise. The amount of inquiry is a hopeful feature, and the pig iron position contrasts favourably with anything experienced in the earlier part of the year. The quoted prices of £3 2s. 6d. for Northampton No. 3 and £3 5s. for Derbyshire are maintained, but the £2 16s. and £3 2s. quotations for Northamptonshire and Derbyshire forge materials are shaded to the extent of 1s. per ton, the demand being almost stagnant. There remains a scarcity of steel-making hematite pig iron. Stocks have been absorbed and deliveries of new material are difficult to obtain. It is noteworthy that whilst exports of finished material were generally smaller last month than in the previous month, pig iron maintained its upward trend. Shipments of forge and foundry qualities, which aggregated between 14,000 and 15,000 tons in August and September and advanced to 36,324 tons in October, exceeded 40,000 tons in November. Acid pig, too, showed a further increase. The total exports of all descriptions of pig iron were considerably more than double the tonnage of our imports, though both Sweden and Belgium sold us more forge and foundry pig, and consignments of basic from France increased from 6591 tons to 12,510 tons.

Coke Values.

Midland blast-furnacemen have been in consultation with the coke oven men as to the new basis price for furnace coke, but so far negotiations have proved abortive, and furnaces will depend on the open market for supplies after the turn of the year. Associated furnaces were willing to renew the agreement with the cokeries, subject to the scale being based on a minimum of 12s. 9d., an advance of 1s. on the current rate. Oven men demanded an advance of 2s. 6d., and so the conference at which the matter was debated came to nothing.

Steel.

The downward course of selling values of steel has been definitely arrested, and most producers of structural material are now asking advanced prices. The position has not altered quotably from last week, but the efforts to strengthen prices have been supported by an increased number of firms. One big organisation which has developed output with new equipment is, however, an exception, for it is still prepared to do business at "cut" rates. For ship, bridge and tank plates £8 is now the general quotation for the Midlands. One or two firms are open to accept £7 17s. 6d., however, which suggests that no basis has been agreed upon. Sections, which could be bought down to £7 recently, are not obtainable at less than £7 2s. 6d. now, and firms on the North-East Coast want £7 5s. Local steel masters report that inquiries from constructional engineers come in with fair regularity for miscellaneous requirements, such as works extensions, station rebuilding, municipal undertakings, with a large amount of electrical development. The future prospects in this department are decidedly hopeful, but, with a very large margin of capacity, any important rise in prices is unlikely. Continental competition is not so keen and prices have slightly advanced, joists being quoted at 1s. to 2s. dearer. The continental steel works are reported to be filled up with work until February. In view of the numerous complaints of unprofitable prices on the Continent, some Midland users are inclined to buy foreign steels speculatively in view of possible advances, although the prospects of delivery are probably remote. Steel billets delivered at £5 5s. offer just sufficient advantage against the home price of £6 2s. 6d. to make such purchases worth while, provided the consumer can afford to wait for delivery.

Galvanised Sheets.

Makers of galvanised sheets are still booking regularly, almost on a world-wide scale, the tonnages, however, being slightly smaller. Nearly all the new work is for delivery in the first three months of next year, a premium having to be paid for prompt supplies. The Mediterranean ports continue to be somewhat conspicuous as buyers. Mills have still a heavy weight of orders to be worked off. Some of them have sold their output up to the end of the first quarter of 1926. This department of industry has received steadier support than any other in the trying times through which manufacturers of iron and steel have been passing. The total shipments this year to the end of November were 644,950 tons, against 598,829 tons last year and 551,716 tons in 1923. The value of the current year's trade is, however, rather less than that of its predecessor.

Scrap.

Steel scrap is firm, but efforts to obtain an increase on the figure of £3 7s. 6d. for delivery in South Wales have met with little, if any, success.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE iron and metal markets this week are in a comatose condition, and no return to activity is expected before the second week in January. A very small amount of business was done during the first part of the present week, but nothing of importance is expected next week. There seems, however, to be a general belief that prices, both in iron and steel and in non-ferrous metals, will be better in the New Year, partly as a result of the larger orders expected for textile machinery and partly because it seems difficult to suppose that trade can be any worse than it has been during the last quarter. In the iron and steel section there is, besides, the question of dearer fuel which has to be faced, and makers are unanimous in

their decision that it will be impossible for them to pay any increased cost in this respect; and therefore the consumer must pay it. They assume that fuel prices will advance, and this is certainly extremely likely.

Metals.

The market for the non-ferrous metals seems inclined to show a little improvement this week, although, of course, there is very little actual business being done in metals on the Manchester Exchange. Hence it is not business here which is causing the reaction; but there is an opinion that the setback in copper prices had gone quite far enough by the middle of last week. That standard copper should be forced below £60 per ton, simply because of German and French financial difficulties, is a little unreasonable; for if those two countres cannot work so well, extra work ought to come to the consumers in Great Britain and America, and the world consumption of copper should not suffer much, if at all. The reaction from the lowest prices has begun; and if it can begin just when everyone is preparing for the holidays, this of itself is a fairly strong indication that prices had fallen too far. The prices for copper at the end of 1925 are about the lowest of the year, and all through the year they have aways been very moderate. An enormous amount of electrical work has yet to be done, and the consumption of the metal is increasing very steadily, and is likely to increase during the coming year. Hence it is impossible to take a pessimistic view of the future; and it seems quite probable that those consumers who replenished their stocks of metal last week will have cause for congratulations. Recent statistics published regarding the American position are quite favourable, and indicate that there is as yet no increase in the production. Apparently the main reasons why the market did not respond immediately to these statistics was the continued depression in Germany, and the fall in the French Exchange. The market for tin has been rather irregular, and at one time "bears" of the metal seemed to be having a good innings. The French speculators were selling, some of them perhaps being actuated by the lower value of the franc; but America did some buying; and there does not seem to be any cause for alarm. One is inclined to believe that the reaction from the depression may continue for a time; but, of course, a good deal depends upon whether America is about to buy substantial quantities. In the market for lead the slump seems to be over for the present. It has brought prices down from a very extravagant height, and has done good in so far as we have got away from extravagant prices. The market for spelter keeps fairly steady, and there seems to be no apprehension of any serious fall in this metal. Stocks of spelter are rather low, and the industrial demand keeps up well. Naturally the market was affected by the recent position of copper and lead, but this was merely a sympathetic influence.

Pig Iron.

There is now so little business moving in the foundry iron market here that it is impossible to say whether or not makers will be able to enforce the rise which was announced when coke prices were definitely put up. Sellers here declared that the new prices for Derbyshire No. 3 were to be not less than 73s. 6d. to 74s. delivered in Manchester, and we shall probably have to wait until the New Year holidays are out of the way before it will be possible to say that the new prices for pig iron have been established. All will depend upon whether or not the actual demand for pig iron is large enough to keep all the active furnaces supplied with orders; for if not, the price will probably sag again as it did during the early part of December. Of course, the fact that the cost of making iron is proportionately higher will check any tendency to start the idle furnaces, even if the price in Manchester could be raised to 75s. per ton.. A very considerable advance would be needed now to bring more furnaces into operation. It is said that there is a better chance for Scotch pig iron in the New Year, and merchants are looking forward to a larger business; but no very great business can be done here in Scotch iron so long as the railway rates remain as they are.

Finished Material.

There is no change in the position of malleable iron, but in the manufactured steel trade there is a steadier feeling. It is believed that the very reckless cutting of prices is to be discontinued, and that the price of steel plates, at any rate, is to be kept from falling below £7 17s. 6d. per ton in Manchester. Your readers know that plates have been done at £7 10s., and there were reports of cutting even below that price. It is to be hoped, however, that if the manufacturers succeed in getting fixed prices for a time they will not attempt too much in the direction of advance; for in that case foreign competition would certainly be stimulated. It must never be forgotten that the foreign maker of plates can get a good profit when he is delivering the material here at £1 per ton less than the British prices. When the difference exceeds this, then the steel trade will be getting into the unhappy position of the malleable iron trade.

Scrap.

The market for scrap material is quiet, but fairly steady. Dealers here seem satisfied that there will be a better demand for steel melting scrap in the New Year, and are willing to buy any parcels which offer at a cost no more than 52s. 6d per ton on trucks at a Lancashire station. For lots near to the Sheffield market they might even pay a little more than this. The Lancashire forges are still offering 67s. 6d. per ton delivered for heavy wrought scrap iron. In the cast iron scrap market little is being done, but one does not find that prices have fallen further. For ordinary quality of foundry scrap 70s. to 71s. per ton seems about the value. Some holders of fine "textile" scrap are now inclined to ask 75s. per ton delivered, and it seems possible that they will get this price next year.

BARROW-IN-FURNESS.

Hematite.

The best evidence of a return to better conditions of trade in the North-West hematite pig iron market is the stiffening of prices. The improvement has been slow, and, as was hinted in this letter some weeks ago, the first evidence of more solid business was an increase in price. The increase did not come hurriedly, it evidently being the policy of makers to wait until there were abundant signs of a revival before increasing their prices. An increase was due, for the old price left practically no margin for the most economically run works and meant a loss at others. Recent balance-sheets show how small a margin there has been. The Midlands and Scotch buyers are livelier, and there is a tendency on the part of both to increase their orders and also to place orders for forward delivery. The latter is the best sign one could have of returning confidence. Wales is a customer to a better extent. Business with the Continent is only poor, the rate of the French franc interfering with business. American trade fluctuates, but further orders are likely. There is a bigger inquiry and a bigger demand for special qualities of iron, and ferro-manganese is experiencing a better trade.

Iron Ore.

The iron ore trade is improving, for, apart from the fact that there is a bigger demand locally, both Scotch and East Coast makers are again taking deliveries. This is a branch of trade that may further improve in the early future. Foreign ore is in better demand, and there is an increase in demand for both Spanish and Norwegian sorts.

Steel.

The steel trade is not in as good a state as the iron trade, and although there are inquiries in the market, orders are not easy to get, competition being keen. At Workington orders are held for moderate sized deliveries spread over a period. As regards Barrow, fresh orders are required to keep the rail mills going. The hoop and small section mills are better circumstanced.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trades.

THERE is a general feeling of confidence in a New Year revival in the steel trades of the city, though they will end the year with only about half the plants working. In those trades which are being heavily hit by foreign competition and which have been endeavouring to get relief under the Government's safeguarding of industries proposals, considerable disappointment has been felt at the announcement that the application is not going to be granted. The only thing for these firms to do, apparently, is to carry on as best they can until there is an advance in the foreign prices, a possibility which is not altogether out of the question. A great deal has been done in the way of eliminating waste and developing modern business methods, but the keenness to secure orders is such that many of them are being accepted at a loss. The holiday that is being taken this Christmas at the local works is varying a good deal, but the majority are closing down on Christmas Eve until January 4th. Some, however, which have more work in hand, are taking only a few days' rest. Although there has been some additional buying of materials for delivery early next year, the general policy has been one of extreme caution, and this has been noticeable in the scrap market, where 62s. 6d. per ton delivered has been the highest price at which business has been done in heavy basic steel scrap.

Engineering Shops Quiet.

After-holiday prospects for some of the important engineering departments are not of a very hopeful character, and one of the great drawbacks is the shortage of work from the shipbuilding centres, which has resulted in a big loss to Sheffield. Depression is of a most acute character, and occasional orders that are being secured have no "weight" about them, and in consequence it is very difficult to arrange production on an economic basis. Railway orders also have not been coming through very freely of late, and the plants get through the work at a great rate. Foreign railway orders are most difficult to secure on profitable terms, and when they are got it is mainly because of the loyalty of old customers who are prepared to place their business with tried firms rather than accept the cheaper prices of our keen foreign competitors. South American railways have been good customers of Sheffield again this year, and several orders for them are at present being carried out in works in the city. A large trade is being done in motor steel and parts, and orders are coming through freely and regularly. A good deal of work from this source has been placed for delivery next year, and there is every possibility of this trade developing at a satisfactory rate. Other active sections are those connected with the electrical industry, and those departments in the city are not only well employed at the moment, but have enough work in hand or in prospect to ensure them working on full time for a considerable time.

Tools, Plate and Cutlery.

Although prices are not so satisfactory as tool makers would like, there is little cause for complaint in the volume of business that is passing, and in at least two of the lines—saws and files—the works are fully occupied, and practically every skilled man can obtain a job. Owing to the depression in the engineering trades, the call for metal saws is on the quiet side, but the free selling of hand saws more than makes up for this deficiency. The sales on export account are well maintained, particularly to the Colonies. An item of interest to the cutlery trade this week is the great dump of German and other foreign cutlery since the announcement of the coming imposition of the duty. Importers have been rushing all the material possible into this country before the end of the year, when the duties come into operation, and the import returns for November show the extent to which foreign material has been dumped into this country. These imoprts increased from £50,000 worth in October to £156,000 worth last month. The figure for November last year was £36,000. A still bigger advance will no doubt be recorded when the figures for the present month are published. The result of this influx of cutlery, chiefly scissors and pen and pocket knives, will be that supplies in this country will be sufficient to last for many months, and it will be a similar time consequently before Sheffield begins to feel the benefit which it is hoped will be derived from the new proposals. A wave of severe depression is passing over the plate industry, and orders are only coming through for small lots. Distributing firms are buying practically nothing. These works will close down for several weeks extending over the Christmas and New Year holidays.

Steel Firm's Jubilee.

The famous firm of Steel, Peech and Tozer was formed in 1875, and so it is now celebrating its jubilee. It was the introduction of the Bessemer method which was virtually the foundation of the undertaking, which was originally styled Steel, Tozer and Hampton, and rails for British and foreign railways and merchant bars were manufactured. In 1883 the title was changed to its present one, and the success which had followed the rolling of rails was an incentive to develop the making of further railway material. The introduction of the Siemens acid furnaces to supplement the steel output dates from 1892, and the firm entered the basic steel trade in 1906. At the Templeborough works there is a plant for rolling billets and slabs which is not excelled anywhere in America or Europe. The melting plant consists of fourteen 60-ton open-hearth basic furnaces, and all the lay-out for dealing with the steel is on an equally extensive scale. Electricity has been brought into use for mill driving and other purposes. Steel, Peech and Tozer are grouped with the United Steel Companies.

Battleship Equipments.

Another Sheffield firm besides that of Cammell, Laird and Co. is interested in the battleship Rodney, which was launched at Birkenhead last week. Moorwoods, Ltd., of the Harleston Ironworks, Sheffield, designed the whole of the cooking apparatus and equipment for this ship, and it is now in course of manufacture. The cooking ranges are all to be fitted with the firm's special system of oil firing, using heavy grade crude oil. These ranges are made of wrought steel plates, with cast iron hot plates. A similar equipment is also passing through the firm's workshops for the sister ship, H.M.S. Nelson, launched a little while ago at the yard of Armstrong, Whitworth and Co., Newcastle, and also for H.M.S. Adventure.

Naval Order for Vickers.

As the Admiralty has placed an order with Vickers at Barrow for the main gun mountings for two of the new 10,000-ton cruisers, the tenders for the construction of which are now being considered, the work for the guns will probably be carried out in Sheffield.

Cutlery Company's Improvement.

The improved position of Martin Hall and Co., cutlery and electro-plate manufacturers, of Sheffield, reported to the annual meeting, has been effected, according to the chairman, by substantial reductions in the cost of manufacture and overhead expenses, coupled with the gratifying increase in turnover, which showed signs of being maintained. The arrangement with Gladwin and Co., another big Sheffield firm, is working satisfactorily and profitably to both companies. Part of the scheme of reorganisation has necessitated the closing of the Birmingham factory and the disposal of obsolete and redundant stock. The closing of the works has effected a saving of a substantial amount without in any way impairing the output and restricting the range of manufactures. It was also announced that the company has made about 500 new patterns, the bulk of them being new lines, and these patterns have enabled the company to show a profit.

Colliery Output Records.

Yorkshire Main Colliery, Edlington, has set up a daily and weekly record in the matter of output. No fewer than 600 tubs were lifted each hour for three hours, making the draw for the shift 5143 tons and the total draw for the week 26,265 tons, which is easily a record. In the previous week the draw was 24,883 tons, and the next best was 24,100 tons drawn last April. Askern Main Colliery, also in the Doncaster coalfield, has beaten its own recent record by drawing 8942 tons in a week, which is a considerable advance over the figures of a year ago. The progress of this pit is very gratifying in view of the fears that were entertained as to its future a few months ago. Another item of news in the coal world is the announcement that the sinkers at Thorne Colliery, the deepest in Yorkshire, are within a few yards of the Barnsley bed in the second shaft. The rich Kent Thick seam which was cut through some time ago is now producing 1000 tons of high-quality house coal a week, and with the completion of the objective, the opening of the Barnsley bed, this colliery next year should take its place as one of the great Yorkshire pits.

NORTH OF ENGLAND.

(From our own Correspondent.)

No Holiday for Steel Workers.

EVIDENCE of the increased activity at the steel works on the North-East Coast is afforded by the fact that there will be no holiday stoppage whatever at Bolckow, Vaughan and Co.'s steel works, whilst the mills and steel plant at the Cargo Fleet Iron and Steel Works will work

over Christmas, the holiday stoppage at these works being confined to two days at New Year. At other steel plants operations will be suspended for two days each week. The blast-furnace plants also continue in full operation, but the shipyards will take an extended holiday from Christmas Eve to Monday, January 4th.

Cleveland Iron Trade.

A quieter feeling has prevailed in the Cleveland pig iron trade this week, but the shortage of business has been less pronounced than is usually the case on the eve of a general holiday. The absence of this seasonal cessation of business caused some surprise, and it has materially assisted to strengthen confidence in the future. Though conditions on the Continent are of a disturbing nature, hope is entertained that foreign firms will be unable to offer to the same extent as heretofore terms sufficiently attractive to exclude producers here from certain markets. Already competition is less keen in one or two branches of the trade, and producers in this district are not without hope of capturing customers who have been placing orders with foreign firms. The general position of the trade is regarded as encouraging, the present demand being almost sufficient to absorb the limited supply of Cleveland pig iron. Makers firmly adhere to the official quotations, viz.:—No. 1 Cleveland, 69s.; No. 3 G.M.B., 66s. 6d.; No. 4 foundry, 65s. 6d.; No. 4 forge, 65s.; mottled and white, 64s. 6d. per ton. These are home quotations, and 6d. per ton is added in all cases for export orders.

Hematite Pig Iron.

A remarkable change has to be recorded in the East Coast hematite pig iron trade. A few weeks ago there was an ample supply of iron to meet requirements, but now there is a very pronounced scarcity. Indeed, something like famine conditions prevail. It seems that the extra furnaces recently put into operation have been slow in producing marketable iron, and owing to the weather and other causes other hematite furnaces have been working badly, so that the output has been reduced just at a time when the need for iron was most urgent. However, the shortage, though acute, is only likely to be temporary, and some of the arrears should be overtaken during the holidays, when the furnaces continue in full blast. It is, of course, impossible at the moment to buy hematite for prompt delivery, and 76s. per ton for East Coast mixed numbers and 76s. 6d. for No. 1 are minimum sellers' prices, some of the makers quoting considerably more. The bulk of the demand is from British works, but there is also a small volume of foreign business.

Ironmaking Materials.

Foreign ore prices continue steady, despite the continued idleness of the market. Fairly large quantities are coming forward under contracts, and it is possible that January will see some improvement in business. Best Rubio ore is quoted at 21s. per ton c.i.f. Tees. Supplies of furnace coke are scarcer than ever, and although some producers are still keeping their quotation at 21s. 6d. per ton delivered at the works, others ask 22s. to 22s. 6d. per ton.

Manufactured Iron and Steel.

Business in the manufactured iron and steel trade has been less active this week owing to the approach of the holidays. The outlook, however, is regarded as very encouraging, and there is every reason to look for a resumption of demand on sound and steady lines in the New Year. Some of the works are already pretty comfortably placed in regard to orders, though the plate mills are still slack on account of the depression in the shipbuilding industry. Prices generally are unchanged, but sales of steel sections have been reported at £6 17s. 6d. per ton delivered on the North-East Coast. Makers are quoting £7 5s. per ton for steel ship plates, although a few weeks ago £7 was accepted.

The Coal Trade.

There is a steady tone in all sections of the Northern coal trade, and if the tonnage supply is not impeded by further wintry conditions shipments should be brisk to the end of the year, save for holiday interruptions, as the collieries are generally well booked up into January. Orders are numerous for more forward positions and prospects seem satisfactory to, at least, the end of March. Beyond that month both buyers and sellers hesitate to commit themselves owing to the uncertainty of the wages position. In spite of the difficulties in regard to tonnage supply the collieries have been able to work steadily. Movements of vessels are not to be relied upon just now. Cases are mentioned of coal standing at the staiths in readiness for vessels which arrived two days after their advised time, and in consequence there has been a good deal of congestion at the ports. With little remaining to be transacted for this month's positions and only a partial interest taken in business over next year, the Northumberland steam coal section is quiet. Values, however, are firm and range at 15s. 3d. to 15s. 6d. per ton for best steams, and 14s. 9d. for Tyne primes. Secondary sorts are fully at 14s. 6d. There is a large output of steam smalls, but these are readily absorbed at steady prices. The Durham market shows no change, and the tone continues good under substantially booked positions to the early part of January. There is a dearth of gas coal supplies for a week or so, and the price is strong at 16s. 6d. for best qualities. Durham coking unscreened are moving away steadily. Both the home and export requirements are substantial at 15s. to 15s. 6d. The coke trade is in a very good position.

SCOTLAND.

(From our own Correspondent.)

A Quiet Ending.

To all intents and purposes business has practically finished for the year. Contrary to the usual experience there has been no rush of orders prior to the Christmas and New Year holidays, and markets have preserved an appearance of inactivity familiar in the last few months. The coal trade may be taken as a possible exception to the rule in so far as the output, which is still somewhat low, is fully taken up meantime. Nothing has occurred during the past weeks calculated to hold out any hope of even a minor recovery in trade, and the general outlook, therefore, is problematical.

Steel and Iron.

The majority of the steel and ironworks are extremely quiet, and there is a strong probability that the New Year holidays will be prolonged. As a matter of fact, some works are already closed. Buyers of steel and iron show a reluctance to purchase anything beyond the actual meagre requirements necessary prior to the stoppage. As a consequence, producers hold fewer specifications. Furthermore, forward inquiries are not such as to inspire confidence in the immediate future of the markets. Continued depression in the shipbuilding industry is to a considerable extent accountable for the dearth of orders in steel and iron. All descriptions of steel plates and sections are slow in the extreme, and the level of prices continues to drop. There has been a slight lull in the demand for steel sheets, but this is regarded as temporary. In any case most makers of thin black and galvanised sheets have enough orders on hand to last for several months ahead. Heavy sheets are not so well placed. Bar iron makers cannot report progress, and it seems quite evident that bar iron at £11 5s. per ton for "Crown" quality offers no inducement to buyers. Imported material and steel are still being substituted by consumers owing to the cheaper costs of the latter. The re-rolled steel department of the bar iron trade has an occasional flutter, but the prices obtainable in competition with foreign goods leave little margin of profit.

Pig Iron.

The restricted output of pig iron is still more than adequate to meet all demands, and prices continue to weaken. Some furnaces are kept in commission merely to provide stocks against any sudden demand.

Coal.

Exporters of coal have been busy arranging for their commitments prior to the holidays, and many of the collieries have their outputs fully taken up until the end of the year. Lanarkshire splints, ells, and steams are now barely obtainable, Fifeshire collieries are well booked for all qualities, while fuels in the Lothians are firmer than they were two weeks ago. All sizes of washed materials are fully taken up, particularly singles and pearls. Deliveries of fuel for gas and electricity works have been heavier, while domestic coal has sold freely at firm prices. Inquiries for future delivery are not particularly hopeful, but neither buyers nor sellers are inclined to commit themselves to any extent.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

HOLIDAY influences have been much in evidence during the past week, and the amount of business which has been carried through has been comparatively small. The fact is that most exporters made their arrangements for loading this month earlier, and operations have been confined very largely to picking up small parcels for the completion of cargoes. The tonnage supply has ruled very good, in all circumstances, and the docks have been well engaged, with the result that shipments have been quite active. These conditions are expected to continue to the end of the month, while some of the more fortunate collieries have good orders on their books for the early part of January. At the same time fresh inquiries coming along are not by any means numerous, and it is not surprising that the tone of the market for forward shipment has a slightly easier tendency. This applies both to the large and small coal market. As regards supplies of coal for delivery over a period, the only new demand is one from a leading Italian shipping company, which has asked for prices for 90,000 tons of Admiralty large coals for shipment over the first five months of next year.

Christmas Holidays.

As mentioned last week, the official holidays in the South Wales coalfield are Friday and Saturday of this week. In this connection the Conciliation Board met at Cardiff on Saturday to consider the position of the afternoon and night men. Instructions had been issued that, where customary, the men employed on these shifts were expected to work on Christmas Eve or forfeit the bonus turn. The workmen desired that these shifts should be optional without involving any loss of the bonus turn. The owners agreed to amend their instructions, and decided that at those collieries where it has been the custom to work the afternoon and/or night shift prior to Christmas Day, and where a company desires to continue the custom, the workmen will be expected to present themselves for work. A man who does not present himself will not be entitled to receive the proportionate parts of the bonus turn in respect of the shifts worked in that week. Where it has not been the custom to work the afternoon and/or night shift the loss of the shift or shifts is not to prejudice a workman in any way. The whole purpose of the owners' decision is to preserve custom. The workmen's side of the Board did not express agreement with the terms of the amended directions and intimated that the whole question would have to be further examined. As regards work at the docks, the coal tippers and trimmers have decided to suspend work on Christmas Eve at 5 p.m. and to work two short shifts on Monday next, the afternoon shift terminating at five o'clock.

Main Collieries.

A conference took place last week between representatives of the Main Collieries, the Mines Department, and members of the workmen's Joint Committee in order to discuss the question of terms for bringing about a resumption of work at these pits, which have been idle for over eighteen months. Nothing definite was arranged, but hopes are entertained that an amicable arrangement will be come to which will permit of work being restarted in the New Year.

Port Talbot Steel Works.

There is a prospect of work at these steel works being resumed. The Neath Board of Guardians on Saturday considered a letter from the company agreeing to meet a deputation from the Board with a view to securing a resumption of work in order to relieve unemployment. A deputation was appointed to meet the directors.

Spelter Works Extensions.

The Swansea Vale Spelter Works at Llansamlet are making considerable extensions in the roasting and acid departments. This work is part of a scheme under consideration for modernising the whole of the plant with a view to meeting foreign competition. The production of the roasting and acid departments will be enlarged and the whole of the processes are being overhauled and improved.

Developments at Swansea Docks.

Recently strong complaints were ventilated at the Swansea Chamber of Commerce regarding the lack of facilities at the docks. At a meeting of the Chamber last Friday the president (Mr. W. Morgan) stated that a deputation had had an interview with Mr. Lowther, the chief dock manager of the Great Western Railway Company, who gave them definite promises which had been officially confirmed in communications. Mr. Lowther admitted that Swansea had not adequate accommodation at the docks and that a lot of the delay complained of was due to the shortage of sidings and also to the obsolete condition of the existing sidings, and he promised that work should be put in hand immediately. The president said he understood that the work had already started. This included six big reception sidings capable of containing seventy-two wagons each. These would be holding sidings. Below there would be ten riddling sidings capable of holding forty wagons each, while it was the intention of the Great Western Company to remove and more or less level what was known as the "hump," and when that was done there would be further accommodation for 1080 wagons. He understood that there was a chance of these sidings being got ready in six months and that they could really look for them within nine months.

Current Business.

Comparatively little business has passed this week, as loading arrangements for tonnage ready immediately before and after the holidays had been completed last week. Purchases have been limited to oddments required to finish off cargoes. The absence of any pressing demand has resulted in the tone of the market becoming quiet, and while large coals for early January shipment are no more than barely steady, small coals certainly have an easier tendency. The conditions after the holidays are likely to be irregular, as, while some collieries have fairly large commitments for the next few weeks, others are not in such a fortunate position and are likely to be in need of business. Chartering operations are on a restricted scale, which points to the fact that tonnage at the disposal of the collieries will not be so plentiful as has been the case of late. Nominally, quotations of coals, patent fuel and coke display no alteration.

Dry Dock Amalgamation.

An official statement has been issued to the effect that the negotiations have now reached a definite stage, and, subject to the confirmation by the shareholders of the Mountstuart Dry Docks and Shearmans Ltd., the amalgamation of Messrs. Elliot and Jeffery with that company will shortly take effect. Messrs. Elliot and Jeffery have acquired from Mr. Frank Shearman the major portion of his interest in the Mountstuart Company, and the directors of the latter firm have passed resolutions agreeing to the union, and also to an agreement with Messrs. John and Thomas Elliot for the running of the combined businesses. Mr. Frank Shearman retains an interest in the company and a seat on the board, and the other directors will be Messrs. John and Thomas Elliot, J. E. Emlyn-Jones, T. H. Mordey, R. Williamson, and F. E. Lewis.

CATALOGUES.

TANGYES LIMITED, Birmingham.—Machine tool catalogue No. 319.

HADFIELDS, Ltd., East Hecla and Hecla Works, Sheffield.—Leaflet No. 221, announcing a new valve steel.

HOLT AND WILLETTS, Cradley Heath.—List No. C.S.1, illustrating cranes of all types for all purposes.

W. H. WILLCOX AND CO., Ltd., 38, Southwark-street, S.E. 1.—General oil and grease list and motor oil booklet.

NEGRETTI AND ZAMBRA, 38, Holborn-viaduct, E.C. 1.—Lists C.9 and C.6, describing distance thermometers.

THE BRITISH INSULATED AND HELSBY CABLES, Ltd., Prescot.—Catalogue No. P192, entitled "Pole Line Materials."

BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—Descriptive list No. 5120-B, dealing with field rheostats.

THE MIDLAND ELECTRIC COMPANY, Ltd., Birmingham.—New illustrated catalogue of ironclad switch and fuse gear.

THE BILLING TOOL COMPANY, 101, Clerkenwell-road, London, E.C. 1.—Catalogue of wood and metal working small tools.

KARRIER MOTORS, Ltd., Huddersfield.—Brochure detailing the advantages of the "Karrier" six-wheel type chassis.

F. BRABY AND CO., Ltd., Petershill-road, Glasgow.—Pamphlet introducing the company's "Venteolite" galvanised sheets for roofing.

J. KEITH AND BLACKMAN COMPANY, Ltd., 27, Farringdon-avenue, E.C. 4.—Leaflet dealing with fan plants for the removal of dust.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	21/-
(1) Spanish	18 6
(1) N. African	18/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/-

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) SCOTLAND—		
Hematite	3 17 6	—
No. 1 Foundry	3 19 6 to 4 2 0	
No. 3 Foundry	3 17 6 to 3 19 0	
N.E. COAST—		
Hematite Mixed Nos.	3 16 0	3 16 0
No. 1	3 16 6	3 16 6
Cleveland—		
No. 1	3 9 0	3 9 6
Silicious Iron	3 9 0	3 9 6
No. 3 G.M.B	3 6 6	3 7 0
No. 4 Foundry	3 5 6	3 6 0
No. 4 Forge	3 5 0	3 5 6
Mottled	3 4 6	3 5 0
White	3 4 6	3 5 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 2 0 to 3 2 6	
„ Forge	2 15 0 to 2 16 0	
(3) Derbyshire—		
No. 3 Foundry	3 6 6 to 3 7 6	
Forge	3 1 0 to 3 2 0	
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 0 (a) / 4 10 6 (b) / 4 15 6 (c)	— / — / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 5 0	—
Best „	—	—
N.E. COAST—		
Common Bars	11 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	11 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up.	7 10 0 to 7 12 6	
Sections	7 0 0 to 7 2 6	
Steel Sheets, under 3/16in. to ½in.	9 2 6 to 9 5 0	
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	7 5 0	—
Angles	6 17 6	—
Boiler Plates	11 10 0	—
Joists	6 17 6	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light „	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
MANCHESTER—		
Bars (Round)	8 5 0 to 9 0 0	
„ (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	7 17 6 to 8 5 0	
„ (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	7 17 6 to 8 0 0	
Billets and Sheet-bars	6 2 0 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 12 6 to 16 15 0	
Angles	7 2 6 to 7 7 6	
Joists	7 2 6 to 7 7 6	
Tees	8 2 6 to 8 7 6	
Bridge and Tank Plates	7 17 6 to 8 0 0	
Boiler Plates	11 0 0 to 12 0 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/9 to 20/-
Block Tin (cash)	£85 10 0
„ (three months)	£78 10 0
Copper (cash)	£60 0 0
„ (three months)	£51 2 6
Spanish Lead (cash)	£14 5 0
„ (three months)	£14 2 6
Spelter (cash)	£38 6 3
„ (three months)	£37 10 0
MANCHESTER—	
Copper, Best Selected Ingots	£65 5 0
„ Electrolytic	£67 0 0
„ Strong Sheets	£90 0 0
„ Tubes (Basis Price)	£0 1 1
Brass Tubes (Basis price)	£0 1 0
„ Condenser	£0 1 2½
Lead, English	£36 10 0
„ Foreign	£35 10 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/8 to 1/9 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	8/-
„ 6 p.c. to 8 p.c. „	£23 0 0	7/9
„ 8 p.c. to 10 p.c. „	£22 10 0	7/6
„ Specially Refined		
„ Max. 2 p.c. carbon	£40 10 0	15/-
„ „ 1 p.c. „	£50 0 0	17/-
„ „ 0.70 p.c. carbon	£56 10 0	19/-
„ „ carbon free	1/5 per lb.	
Metallic Chromium	3/9 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 15 0 per unit	scale 5/- per
„ „ 75 p.c.	£21 0 0 per unit	scale 6/- per
„ Vanadium	15/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£172 to £177	
Cobalt	10/- per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	15/6
„ „ Ell	16/6
„ „ Splint	17/- to 19/-
„ „ Trebles	17/9
„ „ Doubles	16/9
„ „ Singles	14/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	15/6
„ „ Splints	17/-
„ „ Trebles	17/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/- to 15/4½
Screened Navigation	20/9
Trebles	18/- to 19/-
Doubles	16/6
Singles	15/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	15/-
Secondary Steam	14/6
Trebles	18/7½
Doubles	16/6
Singles	15/-

ENGLAND.

(8) N.W. COAST—	
Steams	23/6
Household	40/- to 45/-
Coke	26/-
NORTHUMBERLAND—	
Best Steams	15/6
Second Steams	14/6
Steam Smalls	9/6 to 10/-
Unscreened	14/-
Household	20/- to 22/-
DURHAM—	
Best Gas	16/- to 16/6
Second	14/6 to 15/-
Household	20/- to 22/-
Foundry Coke	20/- to 22/6
SHEFFIELD—	Inland.
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 27/6 —
„ „ House	24/- to 25/- —
„ „ Large Nuts	17/- to 20/- —
„ „ Small	12/6 to 14/- —
Yorkshire Hards	16/6 to 19/6 —
Derbyshire „	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty „	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
„ „ (Export)	f.o.b. 19/3 to 19/9

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	23/- to 23/6
Second „ „	22/- to 22/6
Best Dry Large	21/6 to 22/6
Ordinary Dry Large	20/- to 21/-
Best Black Vein Large	20/- to 20/6
Western Valley „	19/- to 20 -
Best Eastern Valley Large	19/- to 19 6
Ordinary „ „	18/9 to 19/-
Best Steam Smalls	13/6 to 14/6
Ordinary „	11/- to 13/-
Washed Nuts	19/- to 29/6
No. 3 Rhondda Large	27/- to 27/6
„ „ Smalls	16/6 to 17/6
No. 2 „ Large	19/- to 19/6
„ „ Through	15/6 to 16 6
„ „ Smalls	10/6 to 11/-
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/- to 23/-
Pitwood (ex ship)	30/- to 30/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	38/- to 42/-
Seconds	32/6 to 36/-
Red Vein	27/6 to 31/-
Machine-made Cobbles	55/- to 57/6
Nuts	55/- to 57 6
Beans	42/6 to 45/-
Peas	20/- to 24/-
Breaker Duff	8/- to 8 6
Rubbly Culm	12/- to 12 3
Steam Coals:	
Large	22/- to 23 6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/6 to 18/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Industrial Credit.

THE offer of manufacturers in the Nord to place their credit at the disposal of the State with a view of issuing a loan which would help the country out of its financial dilemma and thereby stabilise currency values is attracting considerable attention. The northern firms have been tempted to take this course to avert a catastrophe which is already beginning to make itself felt in the textile and other industries in which imported raw material has reached exorbitant prices through the depreciation of the franc, and in which a large proportion of the workmen, mostly Belgians, are induced to return to their own country by the higher value of the Belgian franc. If the present state of things is allowed to continue many firms will be obliged to close down their factories. The prevalent idea that a falling franc is favourable to trade is true to the extent that it encourages a speculative foreign buying for the time being, but it is absolutely ruinous to textile and other manufacturers who have to import the whole of their raw material. A temporary spurt in the selling abroad of iron and steel and other native products is a poor price to pay for the ruin of other industries, and so urgent is the necessity to save the situation that the proposal of northern firms is meeting with support from makers in the Lyons and other districts, with the result that there is a prospect of some definite proposal being put forward to substitute industrial credit for the credit of the State.

Inflating Exports.

Meanwhile the iron and steel industries are practically living upon the export trade, which has grown to such an extent that producers have booked forward their output for four and five months. During the first eleven months of the year the quantity of semi-manufactured and rolled steel exported amounted to 1,854,000 tons, or 700,000 tons more than in the similar period of last year, and during the past two weeks, when the franc underwent another heavy setback, there was such a rush of buying on export account that no more metal was available for sale. The situation is particularly disquieting to Belgium and Italy, and in the former country there has been a question of increasing still further the import duties to provide for the difference in money values. Should that course become general the outlook will become very serious for the French iron and steel trades. It is obvious that an artificial stimulus to trade can only be temporary, and it is quite possible that a contraction of foreign business will result in an era of unemployment, from which this country has so far been practically free. In Italy the Minister of National Economy has found it necessary to confer with representatives of the metallurgical and engineering associations as to what should be done to protect their interests from the dumping of French iron and steel and other products. During the first eight months of the year the importations of pig iron from France into Italy totalled 185,200 tons, as compared with 104,500 tons in the corresponding period of 1924. The imports of French steel ingots increased in the same period from 30 tons to 19,950 tons, rolled iron from 24,700 tons to 135,900 tons, and steel blooms from 832 tons to 90,805 tons.

The Cruiser Duquesne.

Launched at Brest last week, the Duquesne is the first of the 10,000-ton cruisers built according to the limitations imposed by the Washington Conference. It forms part of the first instalment of the programme of naval construction started upon in 1924, when two such cruisers were laid down, the second being the Tourville. With a view of making the most of the limitations French naval architects have aimed solely at obtaining the maximum speed possible and the most powerful armament, and they have succeeded in turning out a type of vessel which possesses many interesting features. Effective armoured plating has had to be dispensed with, except for the protection of the turrets. The total length of the Duquesne is 191 m. and between perpendiculars 185 m. It has a beam of 19 m., and the maximum draught is 6.35 m. The freeboard forward is especially high, and it is expected that the arrangement of the keels will give to the cruiser as much stability as the battleship. The armament will consist of eight 203 mm. guns in four double turrets, two fore and two aft in the axis of the ship. For defence against aircraft there will be eight 75 mm. guns, eight 40 mm. automatic guns, and twelve machine guns. There are two double torpedo tubes of 550 mm. Two folding seaplanes, to be discharged by catapult, will be carried. The four geared turbines with their boilers will be independent of each other, and, developing a total of 120,000 horse-power, it is expected that the cruiser will attain a speed of 34.8 knots. With 6000 horse-power and steaming at 15 knots the range of action will be about 6000 miles. As the new cruisers may be employed on foreign missions and are largely intended for colonial defence, special arrangements are being made for the comfort and convenience of the officers and men.

Foreign Trade.

The returns of foreign trade during the first eleven months of the year show a continued improvement in the values of imports and exports, to which, however, it is hardly possible to attach much importance owing to the fluctuating currency. The imports were valued at 38,534 million francs, an increase of 2544 million francs as compared with the corresponding period of 1924, and the exports were estimated at 40,785 million francs, an augmentation of 3420 million francs. In tonnage there was a heavy decline in imports, which totalled 43,418,890 tons, or 8,296,700 tons less than in the corresponding period of 1924. Coal imports fell from 28,926,451 tons to 22,612,084 tons. The exports amounted to 27,578,373 tons, an augmentation of 839,841 tons. The increases were in raw material and manufactured goods, the latter amounting to 3,767,194 tons, or 520,305 tons more than in the first eleven months of last year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

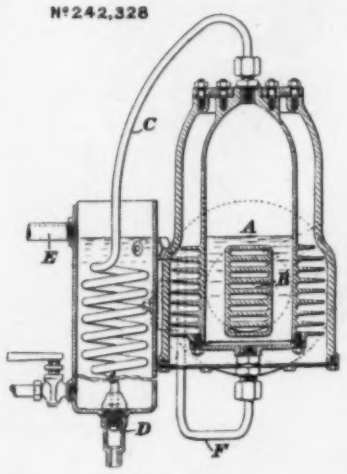
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

242,328. March 25th, 1925.—DISTILLING APPARATUS UTILISING EXHAUST GASES, C. Day, of Mirrlees, Bickerton and Day, Ltd., Hazel Grove, Stockport.

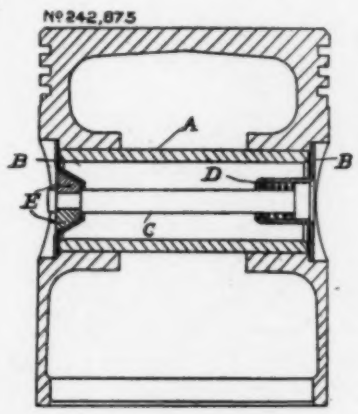
This is a simple piece of apparatus for distilling water by means of exhaust gases. The still is shown at A and is surrounded by the exhaust gases, which also pass through the passage B. The steam generated is taken away by the pipe C,



and is condensed in a coil immersed in cold water, as shown. The outlet end of the coil is provided with an opening to atmosphere at D, so that the internal pressure cannot rise. The water level in the cooling tank is kept constant by an overflow E, and a connection F, from the tank to the still, supplies fresh water as it is distilled. It will be seen that the apparatus is automatic in action and distills water in proportion to the heat in the exhaust without attention.—*November 12th*, 1925.

242,875. April 27th, 1925.—GUDGEON PIN MOUNTINGS, T. B. Murray, South-street, Scotstoun, and the Albion Motor Car Company.

This device is intended to hold the gudgeon pin of an engine in place in the piston. Three variatins of the same general design are illustrated in the specification, and in that which we repro-

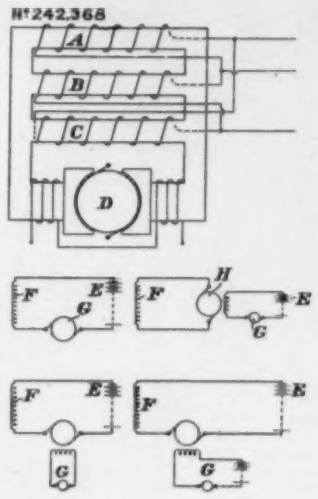


duce the pin A is confined by the caps B B. These caps are held in place by the through bolt C and the force of the spring D. The bolt can be threaded through the two caps and then the two halves of the split cone E are slipped in place, while the spring is compressed. On the release of the spring the whole assembly becomes rigid.—*November 19th*, 1925.

DYNAMOS AND MOTORS.

242,368. August 16th, 1924.—IMPROVEMENTS RELATING TO THE VOLTAGE REGULATION OF DYNAMO-ELECTRIC MACHINES, Adolph Harry Railing and Joseph Pritchard Huggard, both of Magnet House, Kingsway, W.C. 2.

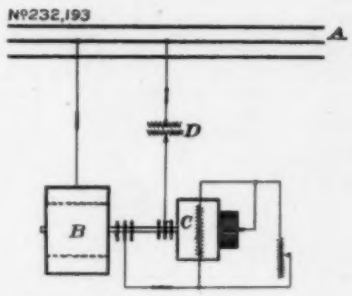
The general principle of the exciter used for exciting an alternator in accordance with this invention is well known. The poles of the exciter are bridged by magnetic shunts A, B and C. On these shunts there are windings which carry the main alternating current, and which govern the magnetic flux passing through the exciter armature. In accordance with one method of carrying out this invention, the alternator is excited from a separate source, such as an ordinary direct-current exciter, or a battery, and the armature of the special exciter is connected in series and in opposition with the separate source of excitation and in series with the alternator field winding. Alternative arrangements are shown in the four lower illustrations. In each case F represents the alternator field and G the armature of the special exciter. E represents a separate source of direct-current supply. These diagrams are more or less self explanatory. In the case of the right-hand upper diagram, the special exciter is connected in series with the field winding of an ordinary exciter H, the voltage of G being in opposition to the voltage of



the battery E. The remaining arrangements will, we think, be understood from the diagrams.—*November 12th*, 1925.

232,193. March 20th, 1925.—MEANS FOR INFLUENCING THE POWER FACTORS OF ALTERNATING-CURRENT MAINS, Siemens-Schuckertwerke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

To the main A an asynchronous machine B is connected and

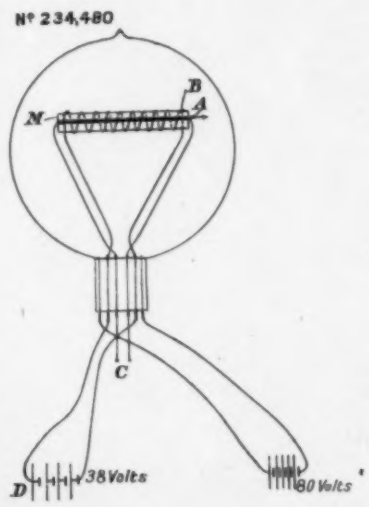


it generates the necessary wattless current for the main. C is a commutator machine which is connected in cascade with the other machine. The compensating effect of the machine B can therefore be regulated. The commutator machine is excited through a regulating transformer D.—*November 19th*, 1925.

TELEGRAPHS AND TELEPHONES.

234,480. May 14th, 1925.—IMPROVEMENTS IN OR RELATING TO THERMIONIC VALVES, Jacques Howadir, of 79, rue Boissière, Paris.

The object of this invention is to economise the continuous current flowing through the cathode of a thermionic valve by providing an auxiliary source of heat. This raises the filament to an initial temperatute before the current is applied to raise the temperature sufficiently for the emission of electrons. The valve has a secondary filament A, which can be brought to a state of incandescence by an alternating current drawn from a public supply system. The filament may be made of tungsten, and may have a relatively large section and be helical in shape. The leads for supplying this filament with alternating current are shown at C. The filament is surrounded by a non-conducting



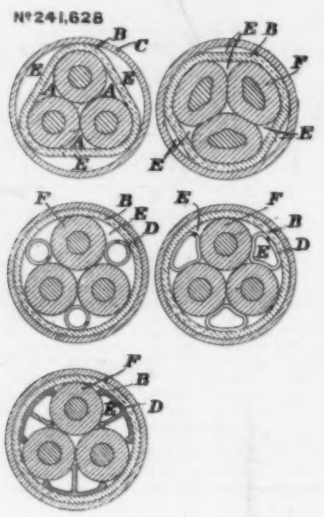
substance M, to which it transmits a certain portion of the heat generated by the passage of the current. The substance M, which may consist of a small mass of quartz, forms a support for the primary filament B, which is wound round the quartz and is connected to a source of direct current D. The filament B has a small section, and is made from a substance which offers less resistance at a high temperature than it does at a low temperature. The secondary filament A, which is heated by the alternating current, gives a substantially constant amount of heat to the mass M, thus transmitting a substantially constant

degree of heat to the primary filament B. The filament B will require a lower strength of current to raise it to the desired temperature than usual, the principal heating being derived from the alternating-current mains.—*November 12th*, 1925.

TRANSMISSION OF POWER.

241,628. December 15th, 1924.—IMPROVEMENTS IN AND CONNECTED WITH ELECTRIC CABLES, British Insulated and Helsby Cables, Ltd., and George Hinde Nisbett, both of Prescot, Lancs.

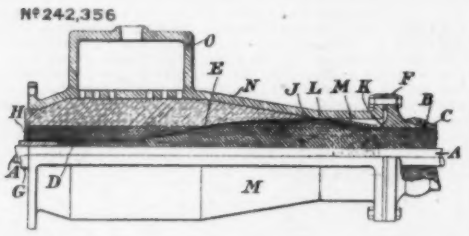
This invention has reference to electric cables, more especially multi-core cables intended for the transmission of high-tension current at voltages ranging from 20,000 volts up to voltages of several times that value. There are several ducts or spaces A, for containing insulating oil or compound, three of which, E, are between the paper-insulating envelope or belt B and the lead sheath C. In the manufacture of the cable, the portions of the lead



sheathing which lie between the points of contact with the paper envelope B are unsupported, and in the winding of the cable on the usual transport drum they become indented or crushed at different points, owing to the spiral lay of the cores in the cable. These indentations are very largely removed and the lead sheating resumes an approximately circular section by the action of the internal pressure of the compound used in filling the cable by the methods shown. The three lower drawings show a three-core cable, in which devices or strips D of metal or other suitable material are employed in the spaces E between the core insulation F and the paper or other envelope or belt B.—*November 12th*, 1925.

242,356. August 7th, 1924.—IMPROVEMENTS IN INSULATED ELECTRIC CABLE JOINTS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, W.C. 2.*

The conductors A are surrounded by smooth machine-wound tape wrappings B of cambric or paper impregnated with petrolatum, and a lead pipe sheath C is formed in place to prevent the escape of the liquid or semi-liquid insulating material, and to prevent the entrance of air and moisture. When making a joint the lead sheath is cut away for a foot or more from the ends of adjacent cable sections, and the insulating wrappings B are cut away to expose a short length of the conductors A. The insulating wrappings are also cut away from the part D to the part E in such a manner that the distribution of potential along the surface D to E shall be approximately uniform. A ring F

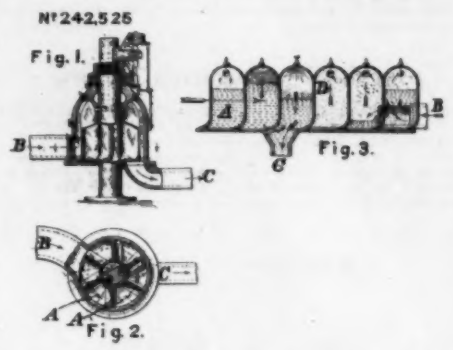


is passed over each end of the cable, and is connected by a wiped joint to the end of the lead pipe sheath C. A slicing sleeve G is soldered over the joint between the adjacent ends of the conductors, and insulating wrappings H are wound over this sleeve. Reinforcing wrappings J are also wound upon the cylindrical surface of the original wrappings B. Electrical stress on the filling oil or compound between K and L is prevented by overlaying the tapered surface from K to L with a metal earth shield M, which is electrically connected as by soldering to the inner edge K of the ring F. The main portion of the outer casing of the joint consists of split sleeve sections M N, provided with flanges adopted to be bolted together to hold the sections about the insulated cable joint. Chambers O on the upper casing are provided for the supply of liquid insulation to all spaces in the casing that are not otherwise filled.—*November 9th*, 1925.

PUMPING AND BLOWING MACHINERY.

242,525. April 17th, 1925.—INTERNAL COMBUSTION PUMPS, G. Evans, Farningham Hill, Farningham, Kent.

The inventor states that this internal combustion pump is specially applicable to the production of a hydraulic jet for marine propulsion, on account of the continuous flow which it produces, but obviously it could be used for other purposes. In the drawings, Figs. 1 and 2 show the general construction of the machine, while Fig. 3 is a diagrammatic development of the working chambers to show the method of operation. The chambers A A are grouped round a fixed shaft and are free to rotate in a fixed casing. The casing is provided with a water



inlet at B, and a discharge branch at C, while the central shaft provides means for the introduction of the combustible charge and the exhaust of the burnt gases. Each chamber has a sparking plug. In the diagram, Fig. 3, the chamber on the left has been partially filled with water, and the combustible charge has been introduced by a pump. In the next chamber the charge is being compressed by the inflow of part of the water being discharged by the third chamber, in which an explosion has just taken place, to force the water out at C. The fourth chamber is in communication with the exhaust gas passage through the port D, and the last two are being refilled with water from B.—*November 12th*, 1925.

MISCELLANEOUS.

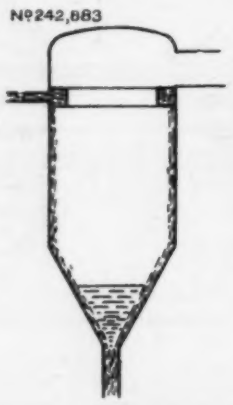
242,768. October 27th, 1924.—IMPROVEMENTS IN ELECTRIC CONDENSERS, The Dubilier Condenser Company, Duncan Works, Goldhawk-road, Shepherd's Bush, W. 12.

The condenser described in this specification consists of a round conductor A, separated by a dielectric B, and a conductor

C, which can be wound as closely as desired on the dielectric B. When the strip C has been wound on the insulation the complete condenser may be subjected to a vacuum in order to draw all the air from the insulation, which can then be impregnated with wax or some other compound.—*November 19th*, 1925.

242,883. May 1st, 1925.—EVAPORATING APPARATUS, N. V. Nederlandsche Installatie Maatschappij Therma, 36, Vonderstraat, Amsterdam, Holland; and A. O. H. Petersen, 9, Bogenstrasse, Altona, Germany.

It is obvious that this patent is intended to cover some special



feature about evaporating apparatus, but the exact point is rather obscure. The principal claim made is for a liquid supplying device for evaporating plants wherein an annular ring is fitted into the upper part of the evaporator and is supplied with the liquid to be evaporated, the underside of the ring being provided with a continuous annular slot adjacent to the wall of the evaporator, as shown in the illustration.—*November 19th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this Office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

WEDNESDAY, DECEMBER 30TH.

ROYAL AERONAUTICAL SOCIETY.—7, Albemarle-street, London, W. 1. Special general meeting of voting members. 5.30 p.m.

1926.

FRIDAY, JANUARY 1ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Cinematograph lecture, "The Manufacture of Ordnance, and the Rolling Mills and Crucible Melting Department at the River Don Works of Vickers, Ltd." 7.30 p.m.

TUESDAY, JANUARY 5TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Sleeve Valve Engine Development," by Mr. W. Ferrier Brown. 7 p.m.

WEDNESDAY, JANUARY 6TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Frequency Variations in Thermionic Generators," by Lieut.-Colonel K. E. Edgeworth. 6 p.m.

THURSDAY, JANUARY 7TH.

INSTITUTION OF SANITARY ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Presidential Address by Mr. Edward Willis. 7.30 p.m.

ROYAL AERONAUTICAL SOCIETY.—7, Albemarle-street, London, W. 1. Paper, "The Experimental Analysis of Frameworks, with Special Reference to the Problems of Airship Design," by Professor A. J. Sutton Pippard. 6.30 p.m.

FRIDAY, JANUARY 8TH.

CHEMICAL ENGINEERING GROUP.—Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1. Papers, "The Manufacture of Hydrogen Suitable for the Hydrogenation of Oils," by Mr. A. E. Knowles; "The Production of Hydrogen by Micro-organisms," by Dr. A. C. Thaysen. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate, Westminster, London, S.W. 1. Third Report of the Marine Oil Engine Trials Committee. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Notes on Salesmanship," by Mr. A. J. Simpson. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE BRITISH BELTING AND ASBESTOS, Ltd., has removed the London offices of its "Asbestos" Department from 132, Commercial-street, E. 1, to 59, Southwark-street, London, S.E. 1

WE are informed that Messrs. Hartley, Sons and Co., of Stoke-on-Trent, have recently been awarded the silver medal of the Royal Sanitary Institute for their "Spiroflow" system of bio-aeration treatment of sewage.

E.N.V. MOTORS, Ltd., of 6, Whitechapel-road, London, E. 1, asks us to announce that it has appointed Mr. W. T. Day its special travelling representative for Great Britain. Mr. Day was for many years with Messrs. E. G. Wrigley and Co., Ltd.

OERLIKON, Ltd., asks us to announce that it has moved its office from Norfolk-street, Strand, to Oerlikon House, 28–31, Essex-street, Strand, London, W.C. 2. Its telegraphic address remains as before, namely, "Oerlik, Estrand, London," but its telephone number has been changed to City 3421 and 3422 (two lines).

EDWARD G. HERBERT, Ltd., of Atlas Works, Chapel-street Levenshulme Manchester, asks us to state that it has opened a London sales office at 68, Victoria-street, Westminster, S.W. 1—telegraphic address, "Allotropic, Sowest, London"; telephone, Victoria 4186—and has appointed Mr. G. W. Risdon to represent it in the metropolitan area.

WE are informed that in consequence of ill-health Mr. Ernest M. Brown has retired from business and has sold the undertaking of Ernest M. Brown and Co., of East Parade, Huddersfield, which he had carried on for many years past as sole proprietor, to Mr. Sidney Armitage, who had been actively associated with the firm for the past fifty years, and for many years has been works manager.

WE are informed that as from December 1st, 1925, the name of Guy F. Dowding and Co., of Bush House, Aldwych, London, W.C. 2, was changed to Dowdings' Machine Tool Company, Ltd. This change arises from the sale of the business carried on theretofore under the title Guy F. Dowding and Co. to the second named company. No material changes in policy or organisation of the business are involved.

END OF VOL. CXL.

Engineering Library

JAN 11 1926

"THE ENGINEER" DECEMBER 25, 1925.

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXL.—No. 3652] LONDON: FRIDAY EVENING, DECEMBER 25, 1925 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 12th January, 1926, for the SUPPLY and DELIVERY of TWO MULTITUBULAR STEAM BOILERS for Admiralty and Somerset House.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W.1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 1144

Assistant Engineers Required by the RAILWAY DEPARTMENT of the FEDERATED MALAY STATES GOVERNMENT for four years' service, with possible extension. Salary 400 dollars, rising to 475 dollars a month by annual increments of 25 dollars a month and thereafter in the event of the officer being retained rising to 800 dollars a month, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but the purchasing power of the dollar in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax is at present payable. Free passages provided. Candidates, age 25 to 35, preferably unmarried, should have received a good theoretical training at a university or recognised college or should have been articled to a civil engineer of good standing. Must be A.M.I.C.E. or hold equivalent professional qualifications and have had not less than two years' practical experience of civil engineering, preferably on a railway. Public school education preferred.—Apply at once by letter, giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting clearly at head of application M/13,983. 1162

Civil Service Commission.

APPLICATIONS are INVITED for the established and pensionable POST of CHIEF MECHANICAL ENGINEER on the staff of the Royal Naval Cordite Factory, Holton Heath, under the Admiralty. Salary £400, rising by annual increments of £20 to £600, exclusive of the usual cost-of-living bonus, which at present amounts to £150 on a salary of £400.

The technical qualifications required, in addition to a thorough knowledge of mechanical engineering, consist of practical experience of (1) the precautions necessary to ensure the maximum standard of safety in the manufacture of explosives, and (2) the best measures for securing this as regards the erection of machinery and plant, together with ability, acquired by experience, to advise in the design and lay-out of machinery and plant for propellants.

All candidates must be natural born British subjects; unless they served in H.M. Forces during the Great War they must also be the children of fathers also natural born British subjects and be already serving in the Royal Naval Cordite Factory. Preference will be given to candidates who served in H.M. Forces during the Great War.

Applications, which should state date of birth and be accompanied by a full statement of qualifications and experience, should be addressed in writing to the SECRETARY of the ADMIRALTY, C.E. Branch, Whitehall, London, S.W. 1. 1114

Crystal Palace School of Practical Engineering.

Founded 1872.

President: J. W. WILSON, M.I.C.E., M.I. Mech. E.
Principal: MAURICE WILSON, M.I.C.E.

The NEW SESSION will COMMENCE on JANUARY 6th. 1080

University of the Witwatersrand, Johannesburg.

DE BEERS' PROFESSOR OF MECHANICAL ENGINEERING.

APPLICATIONS are INVITED for the DE BEERS' CHAIR OF MECHANICAL ENGINEERING at the above University.

The holder of the Chair is assisted by several Lecturers, and the workshops will be under his charge. New Laboratories for the Department are now in process of being built and equipped.

The salary will be at the rate of £1000 per annum, rising to £1100 by two annual increments of £50. An amount of £100 will be allowed for passage expenses to South Africa. In addition, a free first-class ticket is provided from Cape Town to Johannesburg, and half salary is paid during the voyage.

Participation in the University Teachers' Provident Scheme is compulsory.

The appointment, which is a full-time one, is subject to all the conditions and rules now in force, and duty is to be assumed as early as possible.

Further particulars as to conditions of service may be obtained from the SECRETARY, Office of the High Commissioner of South Africa, Trafalgar-square, London, W.C. 2, from whom forms of applications may also be obtained.

Applications (7 copies of each) accompanied by testimonials, should reach the High Commissioner of South Africa not later than the 1st February, 1926. 1137

Bethnal Green Board of Guardians.

INSTALLATION OF BOILERS.

The Bethnal Green Board of Guardians invite TENDERS for the SUPPLY and INSTALLATION of THREE LANCASHIRE BOILERS at their Hospital, Cambridge-road, Bethnal Green, E. 2.

A copy of the specification and of the plan can be inspected at the under-mentioned address any week-day between 10 a.m. and 1 p.m. and 2 p.m. and 4 p.m., Saturdays excepted. A form of Tender and specification will be supplied upon deposit of £5, which will be returned upon receipt of a bone fide Tender.

Sealed Tenders, endorsed "Lancashire Boilers," must be delivered at my Offices, as under-mentioned, not later than 12 Noon on the 19th January, 1926.

The Guardians do not bind themselves to accept the lowest or any Tender.

C. FAULKNER JONES,
Clerk to the Guardians.

Administrative Offices,
Bishop's-road,
Bethnal Green, E. 2.
18th December, 1925. 1142

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Metallurgical Supplement.

The Resistance of Ships in Waves.

The Use of High-Pressure Steam.

A French Hydro-Electric Power Plant.

Research and Modern Foundry Practice.

Plain v. Roller Bearings for Tramcars.

The High Speed Cold Rolling Mill.

A Large Plate Edge Planing Machine.

A Portable Asphalt Plant.

PUBLIC NOTICES

Cape Technical College, Cape Town.

APPLICATIONS are INVITED for the POST of SENIOR LECTURER in ENGINEERING at the above College. Commencing salary according to experience.

Applications in duplicate on the prescribed forms (to be obtained from the undersigned) will be received up to the 10th January. They should be accompanied by certified copies of testimonials of practical and teaching experience, and should state age of applicant. The appointment will be subject to conditions of service, a copy of which will be supplied on application.

Applications and enquiries should be addressed to Messrs. CHALMERS, GUTHRIE and CO., Ltd., 9, Idol-lane, London, E.C. 3. 1132

Australian National War Memorial at Villers Bretonneux.

COMPETITIVE TENDERS are invited for the AUSTRALIAN NATIONAL WAR MEMORIAL to be erected at VILLERS BRETONNEUX, FRANCE.

This competition is limited to:—

(a) Australian Architects or Designers resident in any country, who enlisted for service in the Great War with the sea or land Forces of the British Empire.

(b) Australian Architects or Designers resident in any country, whose sons or daughters enlisted for service in the Great War with the Forces above-mentioned.

Printed conditions regulating the submission of designs may be obtained upon application at the following Offices:—

1. Military Headquarters in the capital city of each State of the Commonwealth.
2. High Commissioner's Office, Australia House, Strand, London.

Designs must be delivered, as prescribed, not later than the 30th April, 1926, addressed to:—

THE SECRETARY,
Department of Defence,
Victoria Barracks,
Melbourne;

or

THE HIGH COMMISSIONER FOR AUSTRALIA,
Australia House,
Strand, London.

Premiums will be awarded for the best designs as set forth in the conditions.

A deposit of Two Guineas for each set of plans and conditions must accompany the application for same, and such deposit will be returned either on receipt of a bona-fide design, or on return of the plans. 1135

City of Wakefield Waterworks.

RYBURN SCHEME.

CONTRACTS FOR CAST IRON PIPES.

The Corporation invite TENDERS for the SUPPLY of the following CAST IRON PIPES and SPECIAL CASTINGS:—

CONTRACT No. 2.—4600 TONS 22in. PIPES.
CONTRACT No. 3.—6200 TONS 20in. PIPES.

Specifications, conditions of contract, forms of Tender, and other particulars can be obtained from Mr. C. Clemesha Smith, M. Inst. C.E., Waterworks Engineer, Town Hall, Wakefield, on and after Monday, January 4th, 1926, on payment of a deposit of Two Guineas in respect of each contract, which will be returned on receipt of bona fide Tenders and the documents supplied.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders, endorsed "Cast Iron Pipes," to be delivered to me not later than Twelve Noon on Monday, January 18th, 1926.

A. C. ALLIBONE,
Town Clerk.

Town Hall, Wakefield,
22nd December, 1925. 1160

PUBLIC NOTICES

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for:—

1500 STEEL TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 122, Gresham House, Old Broad-street, London, E.C. 2, on or after 19th December, 1925.

A fee of 20s. will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Wednesday, 6th January, 1926.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
1141 Secretary.

Metropolitan Borough of Shoreditch.

ELECTRICITY DEPARTMENT.

TENDERS are invited for the SUPPLY, DELIVERY, and ERECTION of the following PLANT, to be installed at the Council's Electric Generating Station, Whiston-street, Haggerston, viz.:—

(a) One 50,000 lb. WATER TUBE BOILER, complete with Economiser, Forced and Induced Draught, &c.

(b) One 10,000 K.W. TURBO GENERATOR, complete with Condenser, Pumps, &c.

Specifications and forms of Tender will be issued on the 4th January, 1926, and may be had upon application to the undersigned on payment of a deposit of One Guinea, which will be returned on receipt of a bona-fide Tender.

Tenders, enclosed in a sealed envelope, endorsed "Tender for Boiler Plant, or "Tender for Generating Plant," as the case may be, and addressed to the Chairman and Members, Electricity Committee, must be delivered at the offices of the Electricity Supply Department, Coronet-street, Shoreditch, N. 1, not later than Noon on Wednesday, 27th January, 1926.

Only Tenders from British firms will be considered.

The Council do not bind themselves to accept the lowest or any Tender.

W. WEEKES,
Borough Electrical Engineer.

Electricity Department,
Coronet-street,
Shoreditch, N. 1.
21st December, 1925. 1134

INSPECTOR-GENERAL OF IRRIGATION, SUDAN.

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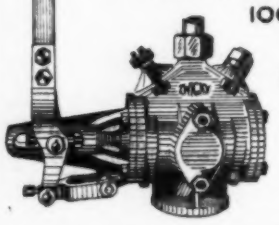

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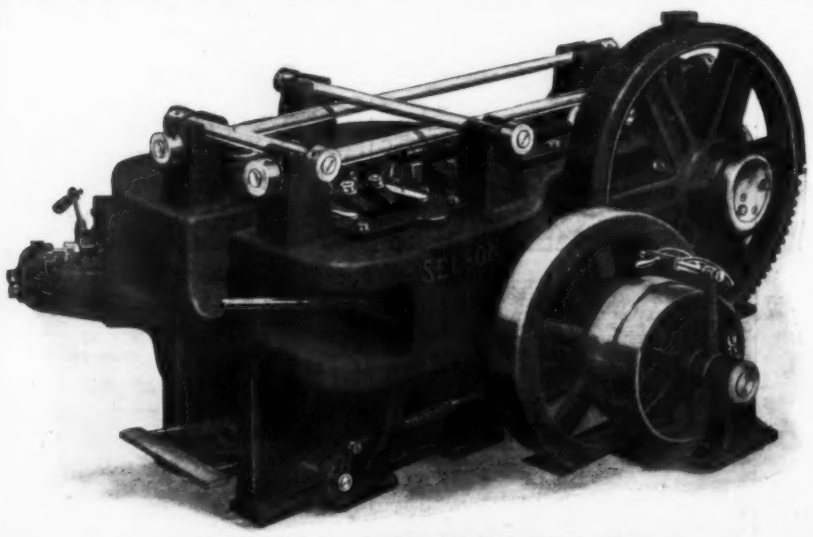

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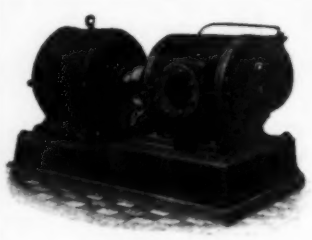

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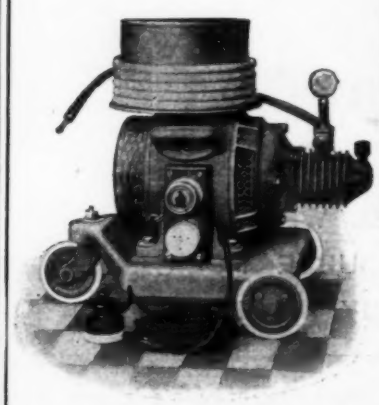

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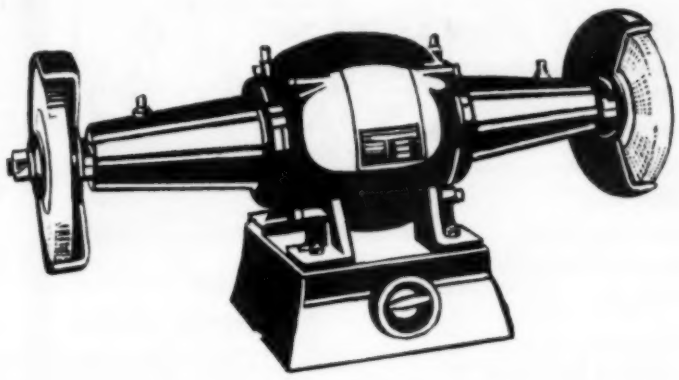

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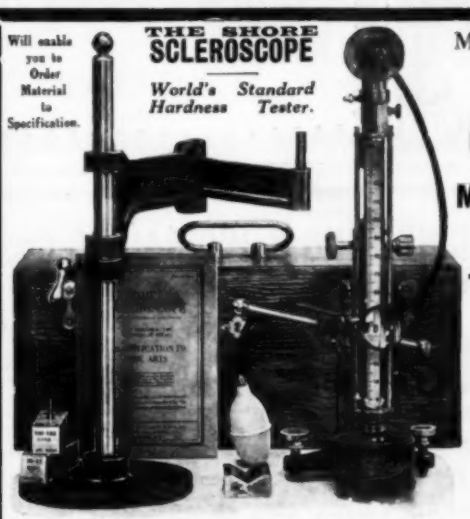

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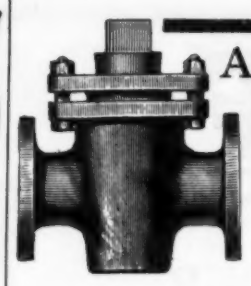

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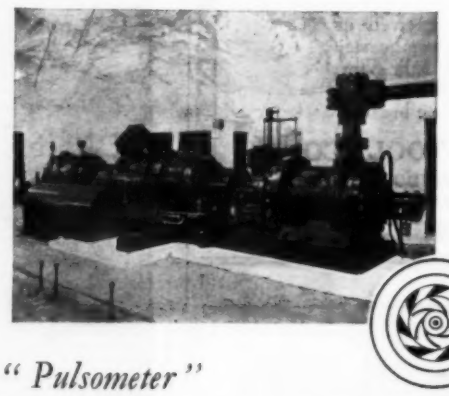

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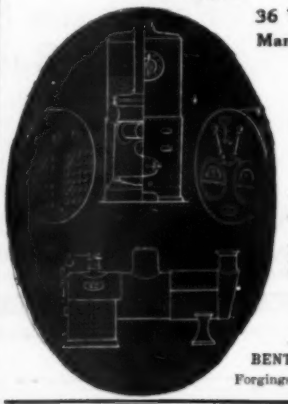

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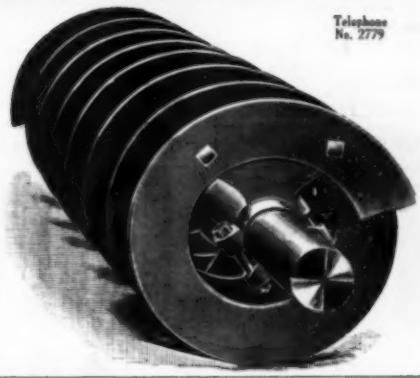

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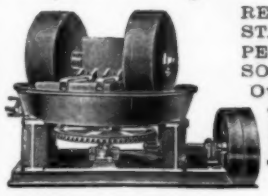

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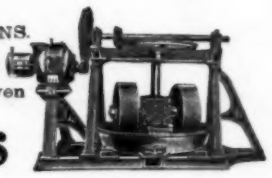

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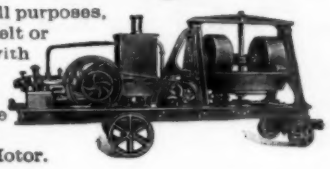

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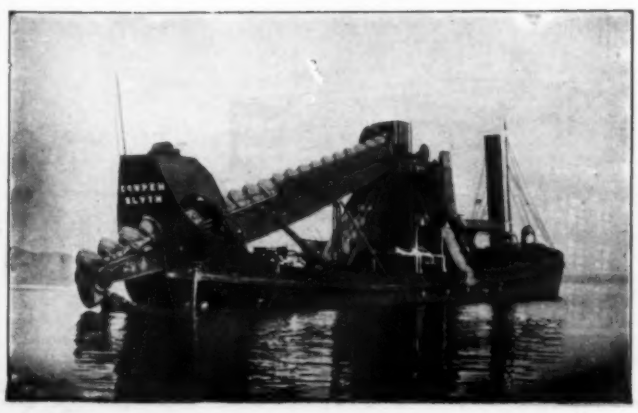

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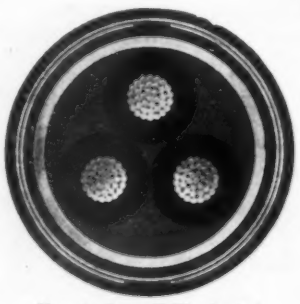

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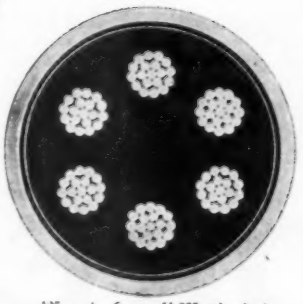

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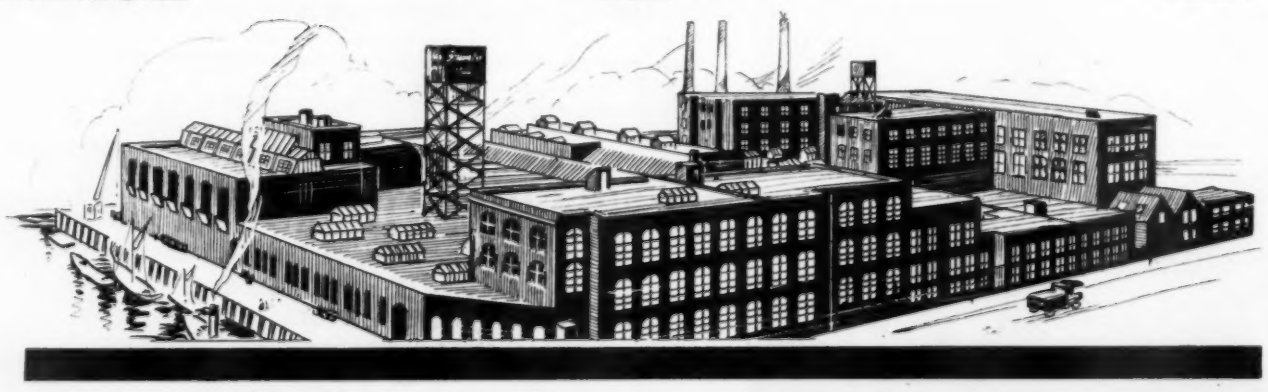

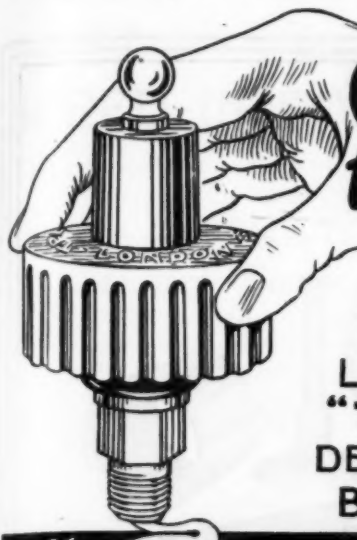

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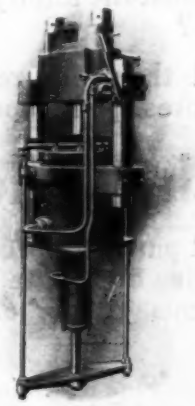

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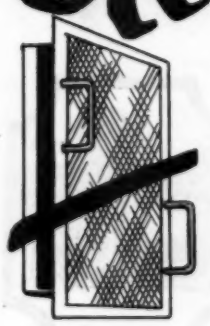

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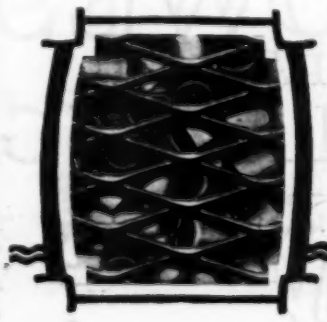

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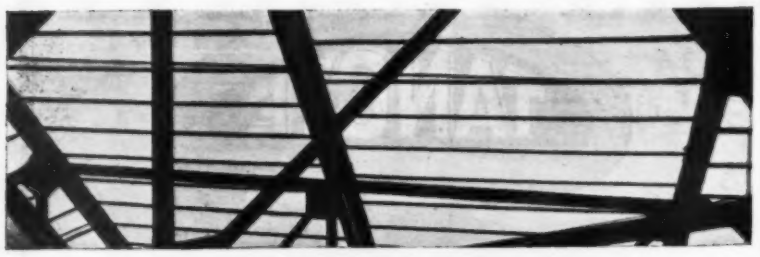

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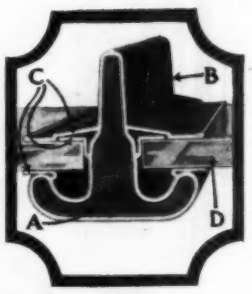

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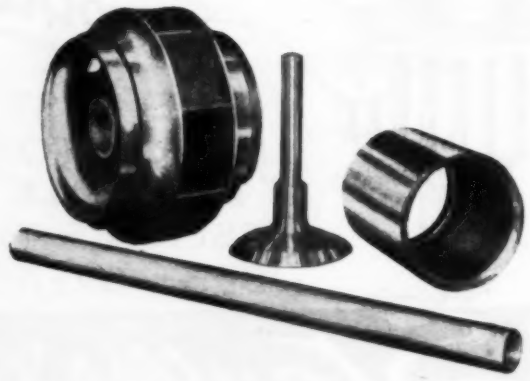

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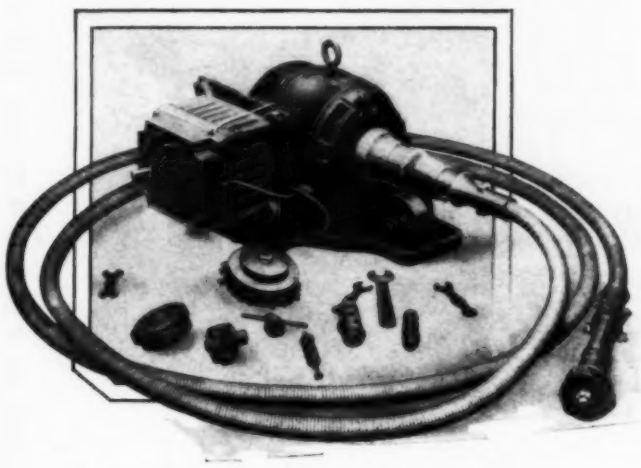

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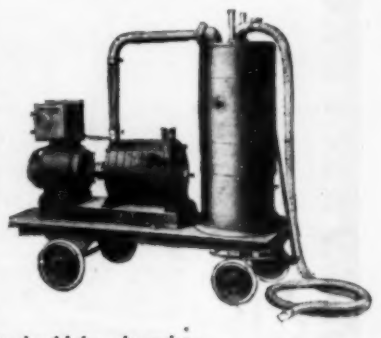

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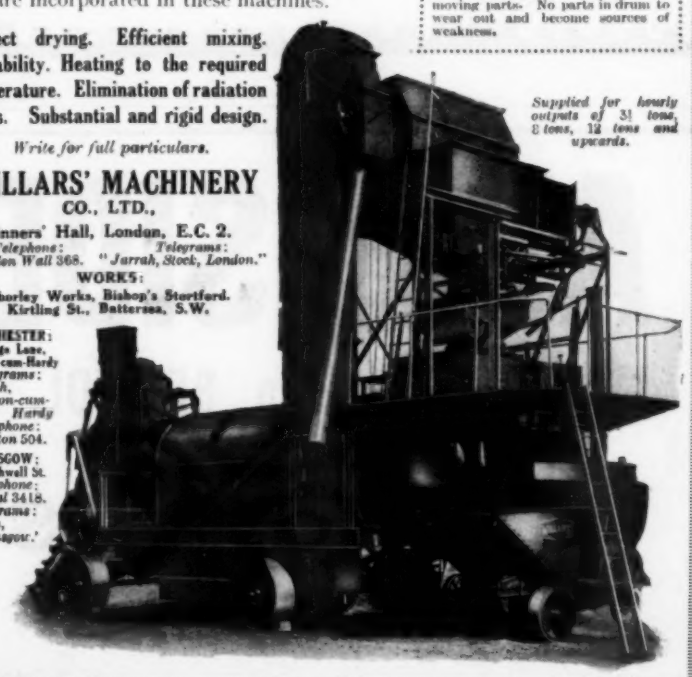

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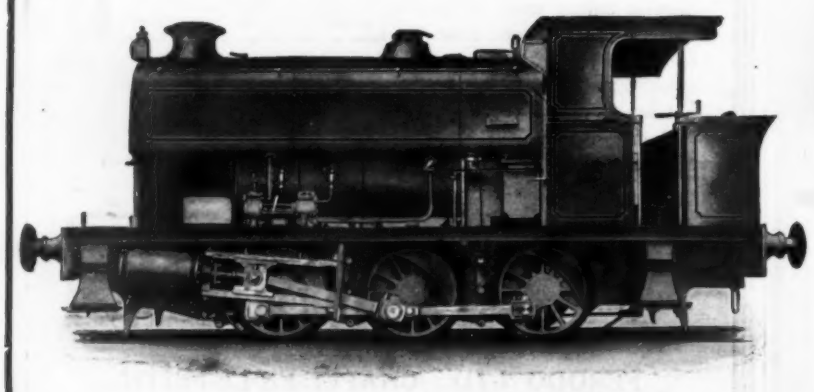

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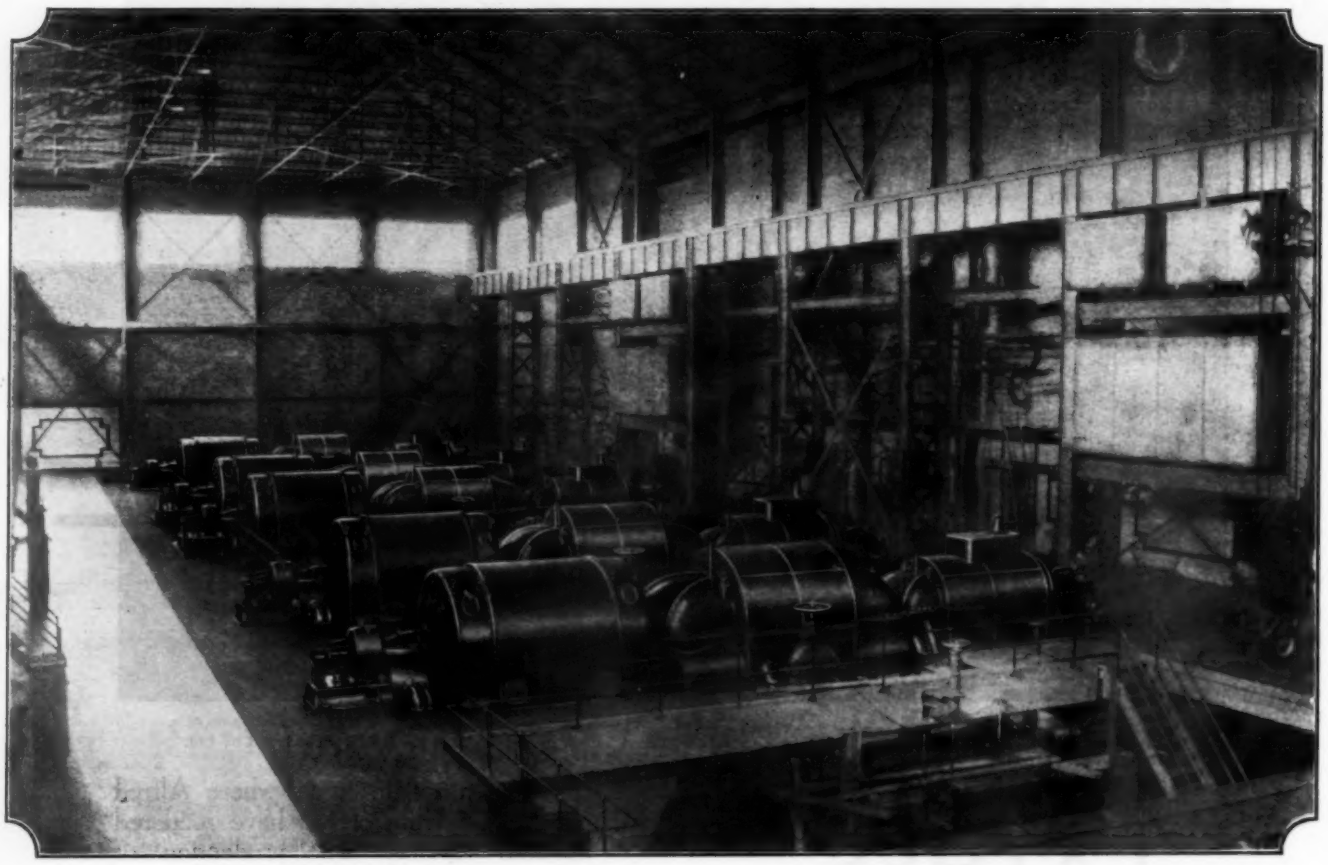

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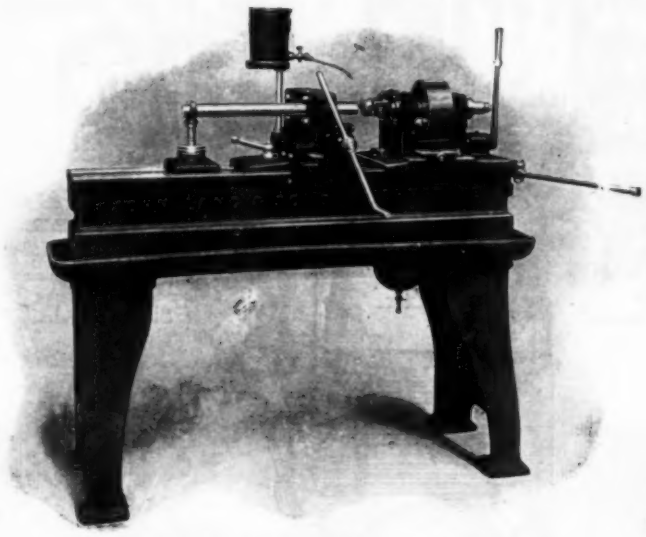

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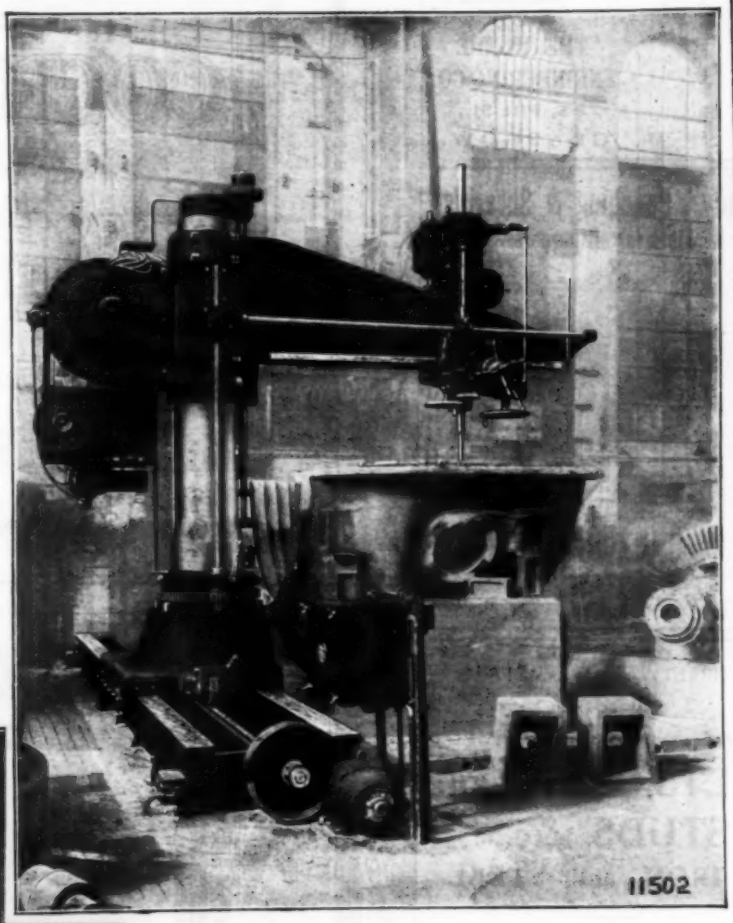

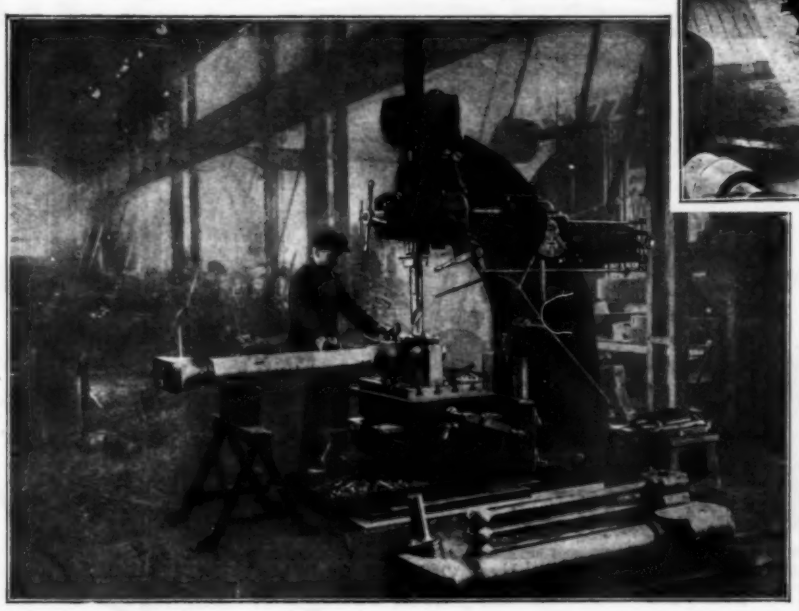

Above we illustrate a large High Speed Heavy Duty Central Thrust Radial mounted upon a traverse bed, in the works of the British Thomson-Houston Co., Ltd., Rugby, to whom we are indebted for the photograph. On the left is illustrated a Box Body Vertical Drill at work on connecting rods, in a Belgian Engine Works. This latter machine can be supplied with a circular form of worktable if preferred.

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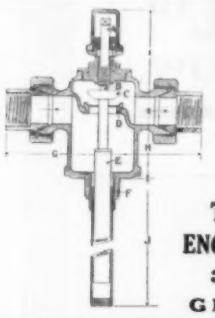

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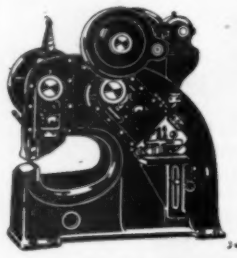

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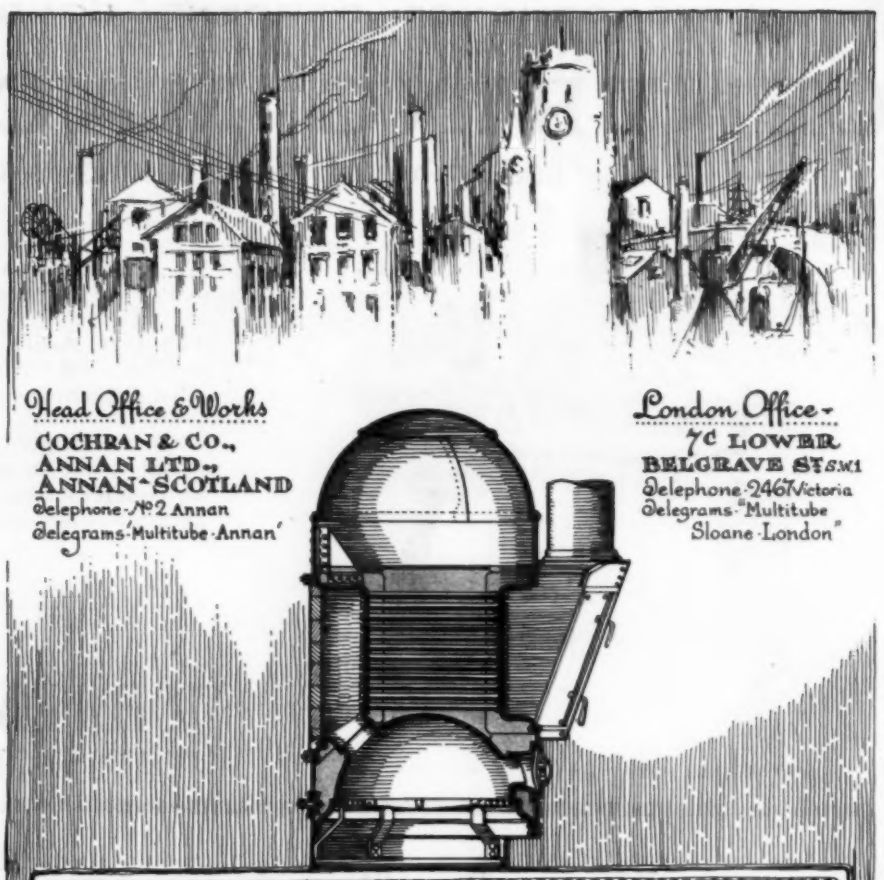
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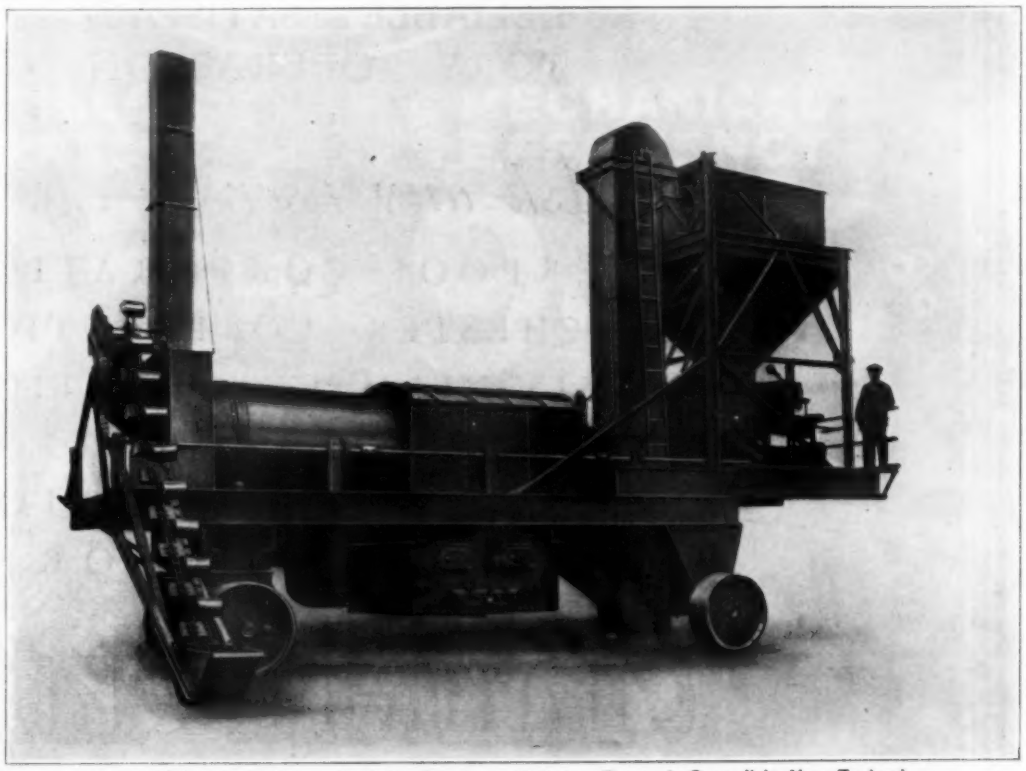

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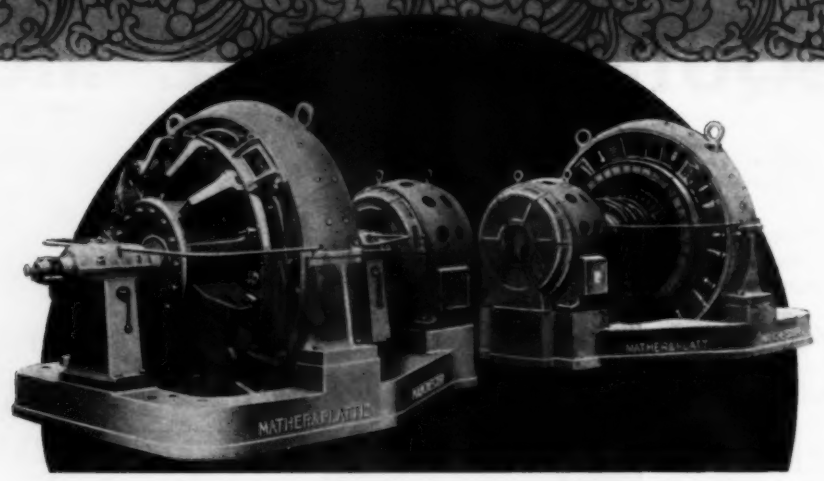

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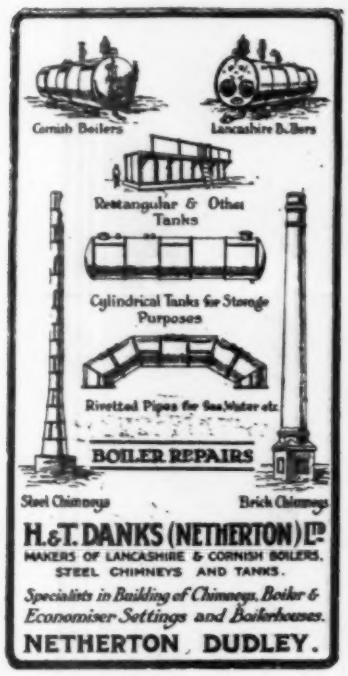

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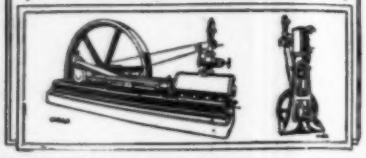

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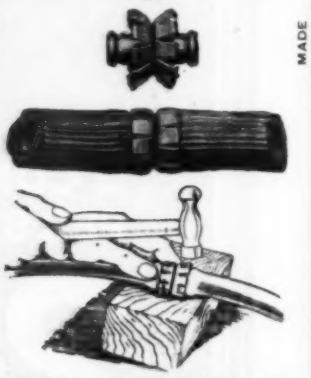

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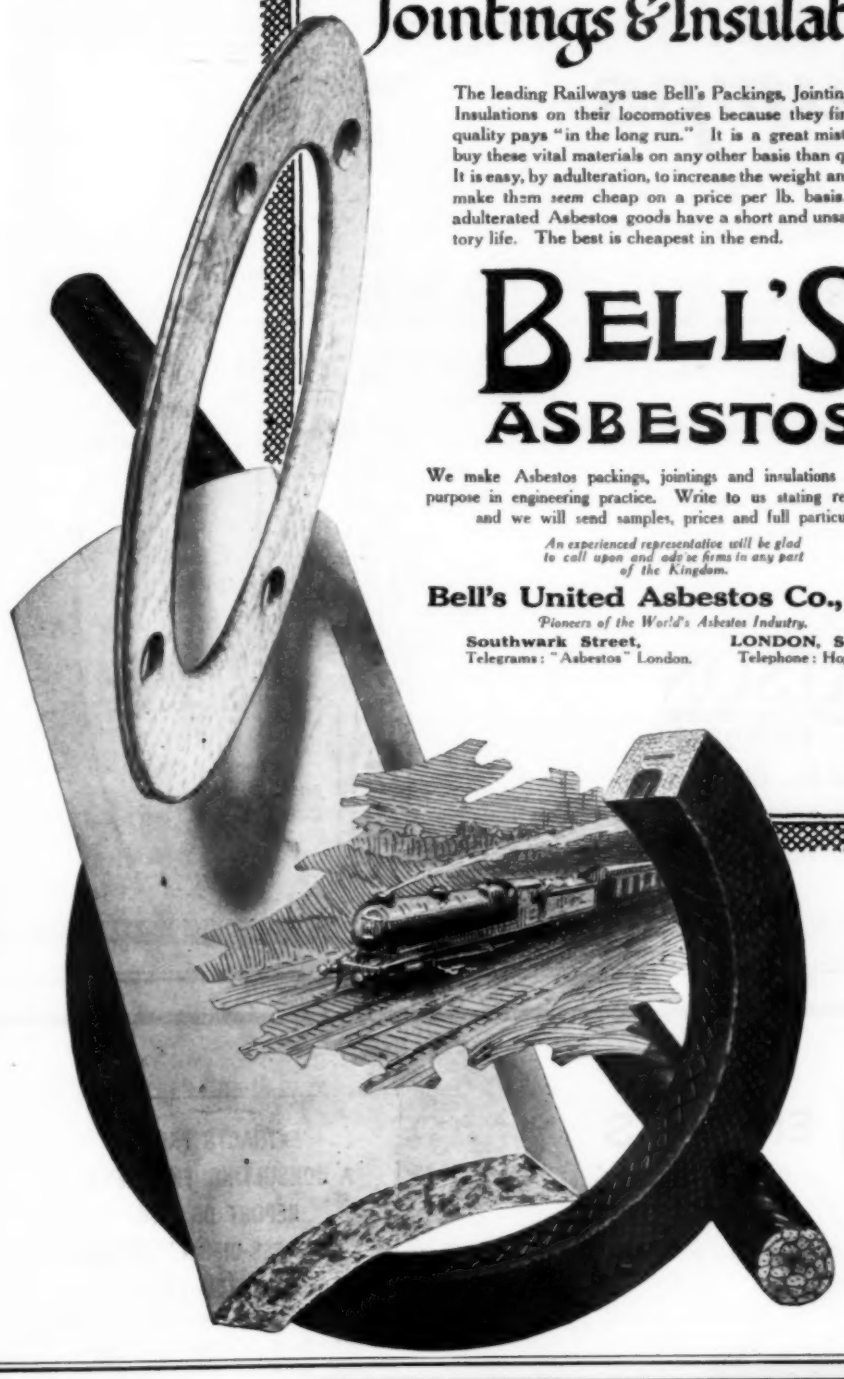

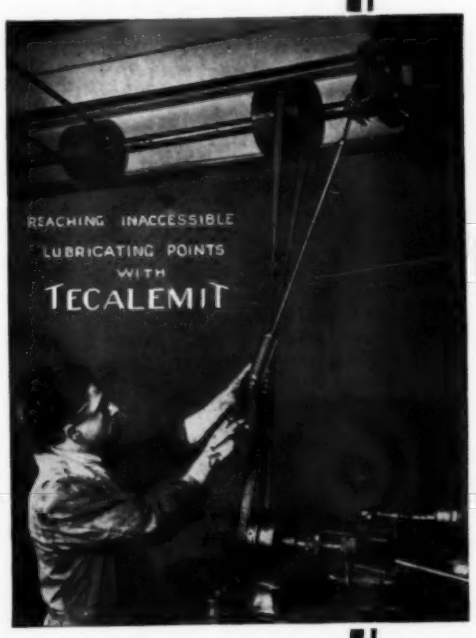

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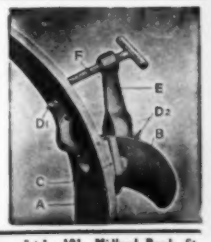

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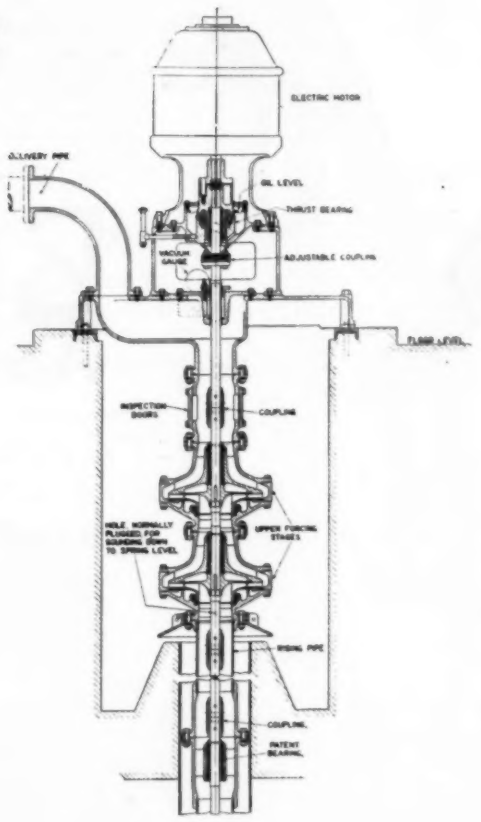
'Mirrlees' Borehole Pumps

Manufactured under and incorporating the patents of Messrs. ASHFORD & LEGGETT, Amritsar, India.

MORE than 30 of these pumps have been installed in India—where, in most cases, they are running night and day continuously for long periods.

Risk of costly breakdowns are avoided by the use of this reliable, correctly designed and mechanically sound pump, which will maintain maximum output from any satisfactory well.



534

The MIRRLEES WATSON COMPANY LIMITED
ENGINEERS, FOUNDERS.
Head Office and Works: 45, Scotland St., Glasgow.
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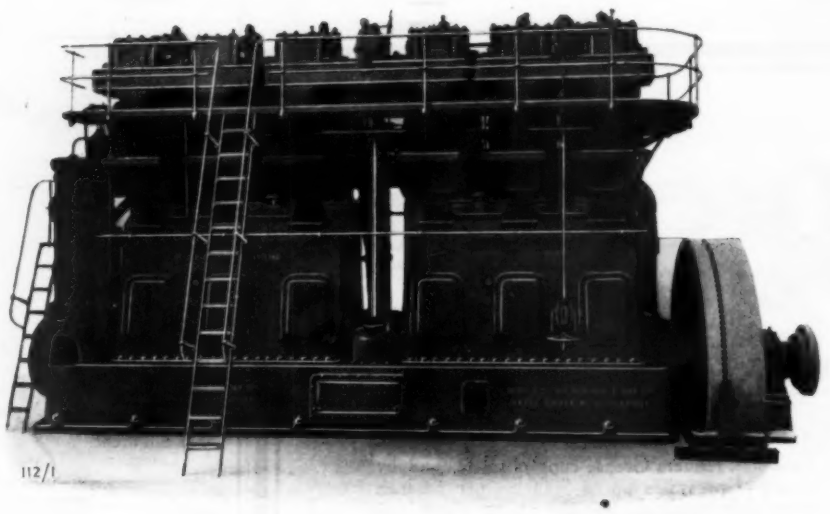
DIESEL MIRRLEES ENGINES

MADE IN STANDARD SIZES UP TO 1650 B.H.P.



6 CYLINDER 900 B.H.P. "MIRRLEES DIESEL" OIL ENGINE (CROSSHEAD TYPE)

MIRRLEES, BICKERTON & DAY, LTD.
7, GROSVENOR GARDENS, LONDON, S.W.1.
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EXTRACTS FROM A CONSULTING ENGINEER'S REPORT ON TWO "MIRRLEES-DIESEL" ENGINES INSTALLED 1912.

PISTONS. "*Have seen, made, and inspected many pistons in my years of experience, and can honestly say I have never seen pistons in such good order after so many years of service—they are almost perfect. . . . . The piston rings are in good order, and perfect fitting as if made this year instead of so many years ago.*"

CYLINDERS. "*Wear so slight as to be negligible.*"

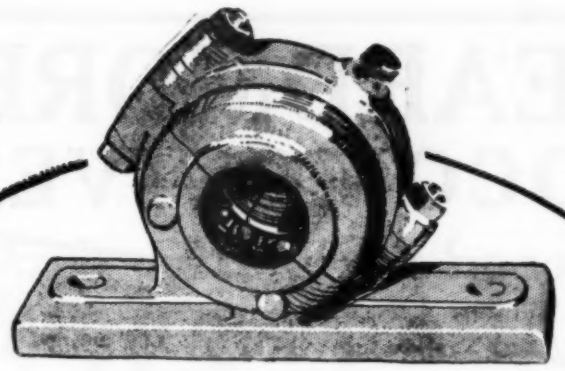
GUDGEON PINS. "*No signs of slackness, free, and in nice working condition.*"

BIG END BEARINGS. "*The big end bearings and crank pins are in very good order—nothing seems wanting—Lubrication must have been good to sustain this condition.*"

COMPRESSION. "*Compression is as good as when new.*"

THE OTHER PARTS OF THE ENGINES ARE REPORTED ON EQUALLY FAVOURABLY.

A Series of High Efficiency : Transmission : Units



The SKF Self-Aligning Ball Bearing Angle Plummer Block

THIS element provides for conditions where an ordinary Plummer Block cannot so well be used.

It is usually mounted with its base placed horizontally and carrying a drive low down in a horizontal plane with the machinery. It is also adaptable for use with its base in a vertical position bolted direct to columns and uprights.

A clean cast outer casing houses an SKF Self-Aligning Double Row Ball Bearing and Adapter Sleeve (with positive locking device) and incorporates efficient grease retaining features.

Practice shows that this and other SKF Transmission units will greatly increase the efficiency and lessen the maintenance costs of lineshafting.

SKF Transmission Equipment includes Self-Aligning Ball and Roller Bearing Plummer Blocks, Angle Plummer Blocks, Side Plummer Blocks and Adjustable Hangers. Self-Aligning Ball Bearing Rigid and Adjustable Housings. Pulleys. Pedestals, Wall Brackets, Girder Clips, Couplings—in fact, everything for the erection of highly efficient and economic lineshafting.

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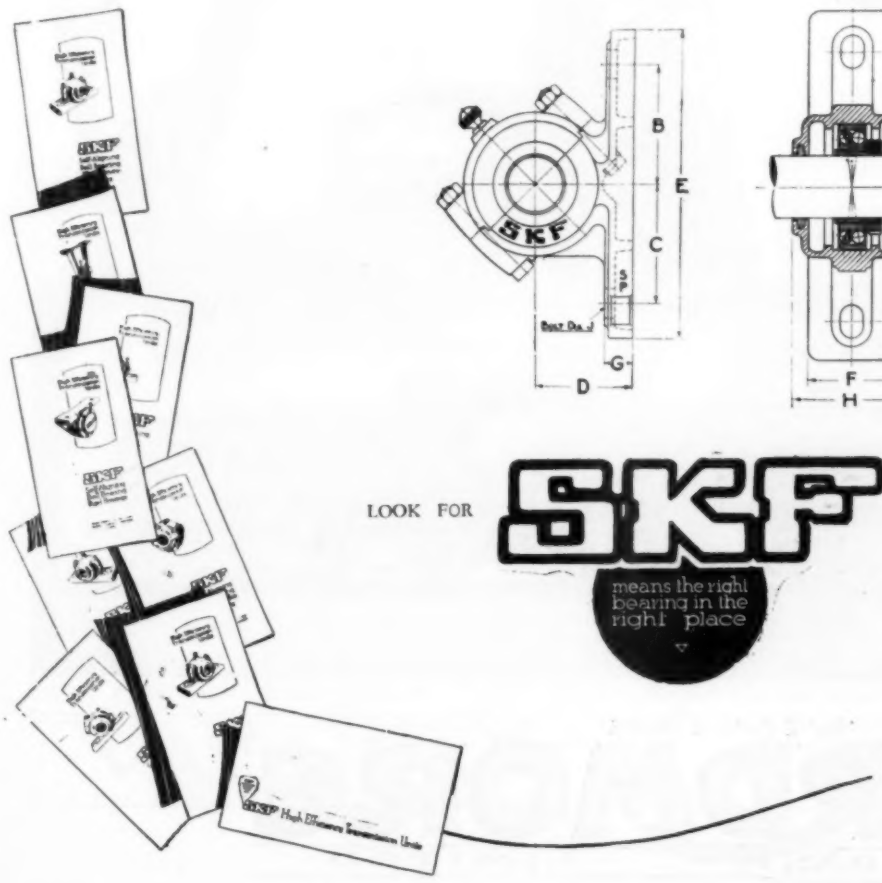

LOOK FOR SKF ON ALL YOUR TRANSMISSION EQUIPMENT AND BEARINGS

SKF means the right bearing in the right place

The new Series of SKF Transmission Equipment Price Lists gives valuable data and information, and shows material price reductions. It should be applied for under reference 'T'

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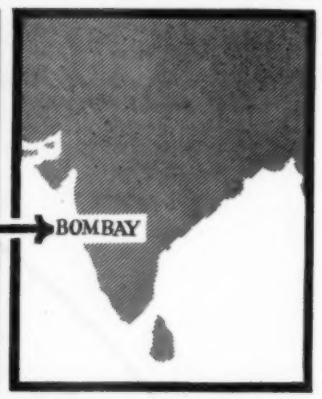
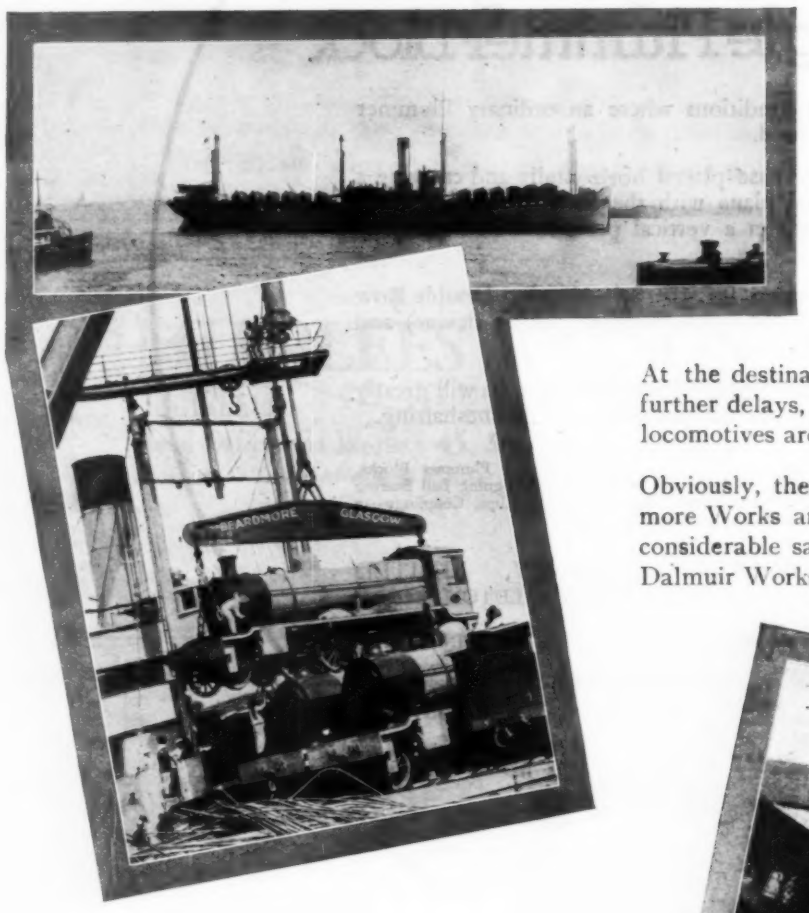
BEARDMORE LOCOMOTIVES

Shipped in Running Order

GLASGOW to BOMBAY

from



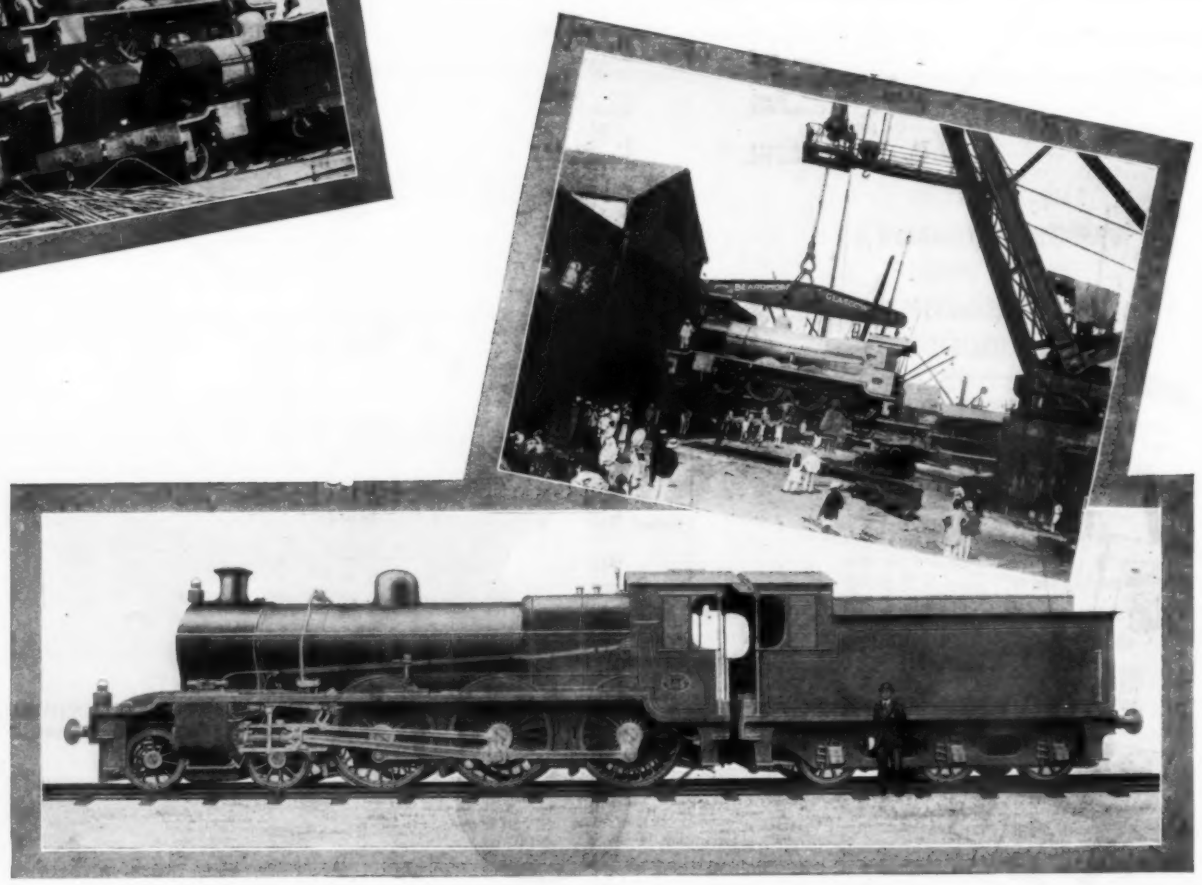


CUTTING OUT

Dismantling, Packing, Journey from Works to Dock, Unpacking and Reassembling.

In the usual way a locomotive works without these facilities has to dismantle each engine and tender, pack the hundreds of smaller parts in specially made crates—some zinc lined—and protect the larger units by means of packing pieces. Intricate lists of parts have to be made out, checked, and painted on the cases. At the destination, the reverse process is set in operation, with further delays, loss of time and hanging up rolling stock, before the locomotives are at length earning revenue for their owners.

Obviously, therefore, the method of shipment which the Beardmore Works are able to employ, as illustrated here, can effect a considerable saving on the final cost of locomotives built at the Dalmuir Works.



WILLIAM BEARDMORE AND COMPANY LIMITED

Locomotive Works: Dalmuir, near Glasgow. **London Office: 36, Victoria St., S.W. 1.**

6 ways

to figure on Turbine Oils

To Engineers who think by the year instead of by the gallon.

Once you introduce Gargoyle D.T.E. Oils into the circulating systems of your turbines you can figure that they will add to the economies of plant operation in six ways, as follows :

1. By ensuring maximum protection of the capital investment in expensive turbine equipment—a definite pounds, shillings and pence value.
2. By ensuring maximum output from that expensive equipment—a definite income that accumulates week by week and month by month.
3. By providing the lowest cost of lubrication per one thousand kilowatt hours' current delivered at the board—an easily proved economy.
4. By reducing oil-sludging, which interrupts continuity of service; when a turbine is shut down, overhead expenses go on.
5. By reducing out-of-service time for inspecting and repairing productive units, and the incidental labour and material costs.
6. By reducing the number of service interruptions for oil draining, cleaning and recharging of the system—an appreciable economy.

How Gargoyle D.T.E. Oils bring about these economies.

The secret lies in their peculiar fitness for turbine lubrication :

They will separate quickly from water or impurities

They will filter readily.

They will carry heat away from the bearings.

They will resist oxidation under continuous service.

They will require less make-up oil in the system.

Who uses Gargoyle D.T.E. Oils?

The majority of turbine-driven power stations throughout the country. More Gargoyle D.T.E. Oils are used for turbines than any other brand of turbine oil on the market.

They are approved and used by many of the leading turbine builders.

The Vacuum Oil Company, Ltd., stand ready to put at your disposal their wide knowledge of steam turbine operating problems and their solutions.

A letter to our nearest Branch Office will put you in touch with an experienced Lubrication Engineer whose services are yours for the asking.

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D.T.E.Oils
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STEAM PUMPS, BELT AND ELECTRIC-DRIVEN PUMPS, PISTON PUMPS, RAM PUMPS,

AND HAND PUMPS FOR WATER, ACIDS, AND ALL LIQUIDS TO ALL PRESSURES.

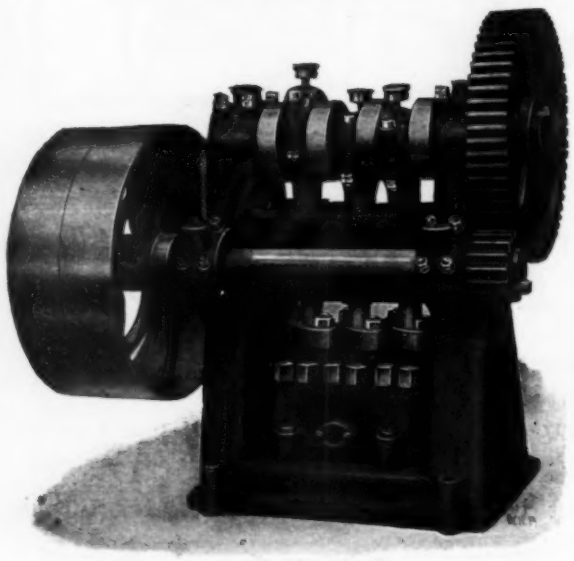


Fig. 7159.—BAILEY'S HYDRAULIC THREE-THROW PUMP
For all pressures and capacities.

160.—RAM PUMP, for Boiler Feeding, Pumping Tar, Ammoniacal Liquor, &c.

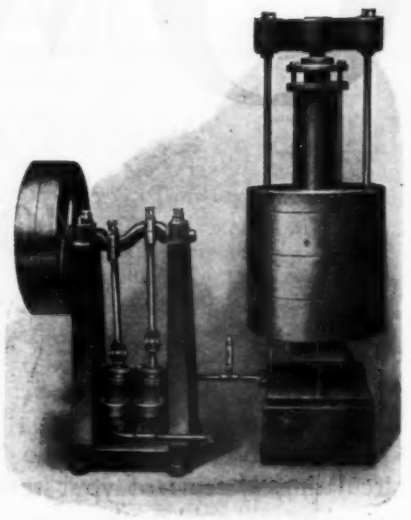
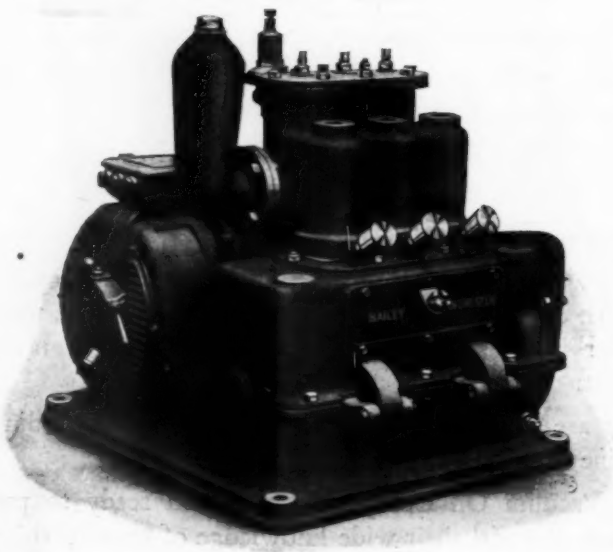


Fig. 7161.—HYDRAULIC PUMP AND ACCUMULATOR.



7163.—"MARINE" ELECTRIC PUMP.
In 2 Sizes: Will pass 5 and 10 Tons per hour.

BAILEY'S "MARINE" ELECTRIC PUMP
(PATENT).

A Fresh Water and Sanitary Pump for Merchant Ships, Yachts, &c.

For House and Farm Supply, Breweries, Distilleries, Deep Workings in Mines, &c.

Working parts totally enclosed. Very compact.

Passes through a hatch 2ft 6in. square.

Complies with the Admiralty Specification.

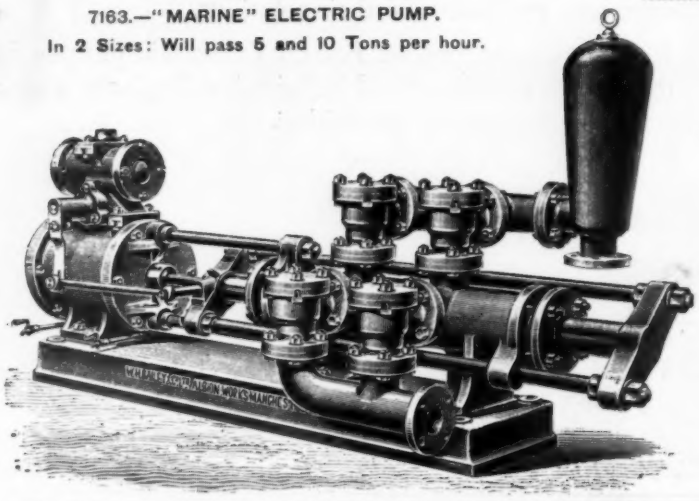


Fig. 6a D.—"DAVIDSON" HIGH-PRESSURE DOUBLE RAM PUMP.
For High Lifts in Mines, &c.

"DAVIDSON" STEAM PUMPS.

"The Pump with the Simplest Slide-Valve."

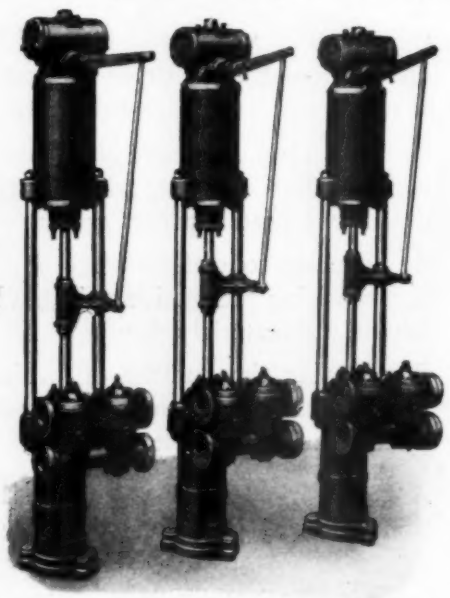


Fig. 50 D.—"Davidson" Economical Boiler Feed Pumps with new Valve Motion, which works without lubrication.

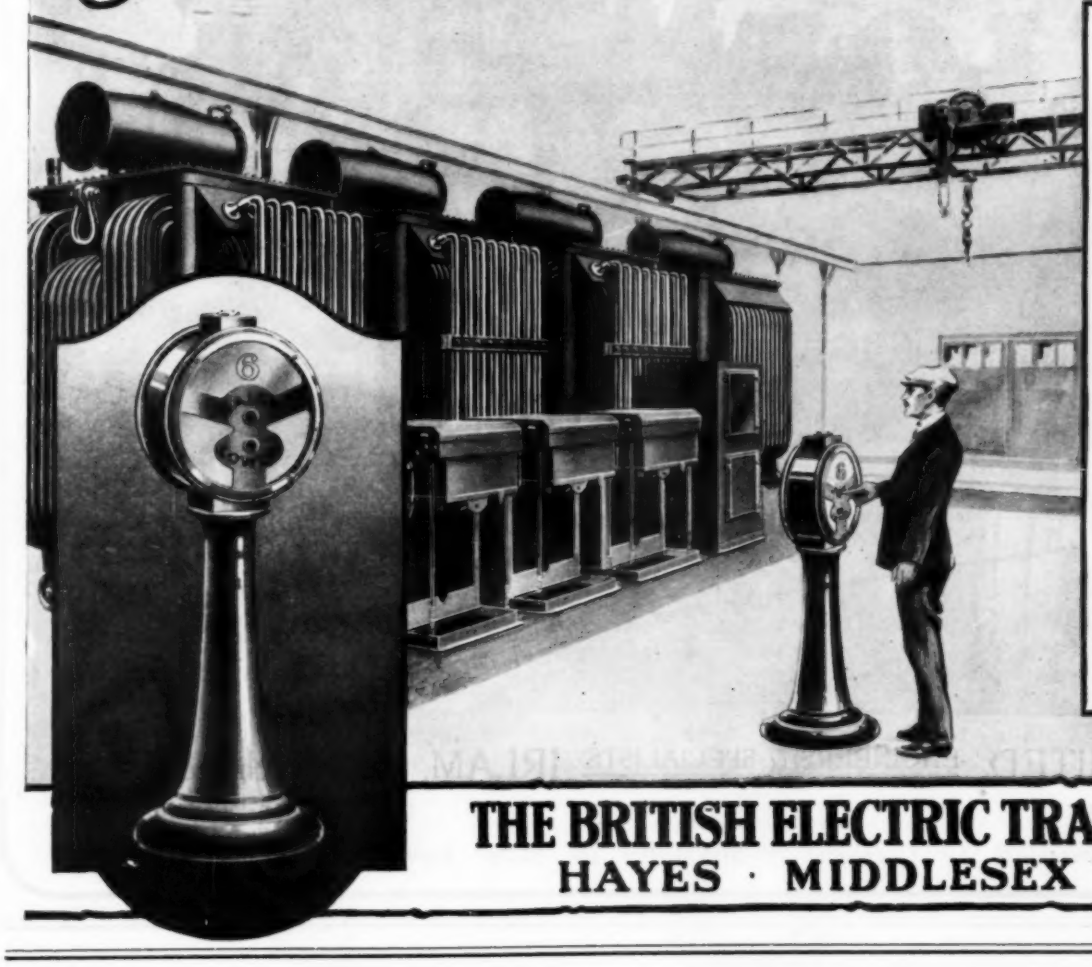
BAILEY'S "DAVIDSON" PUMPS have for over 40 years maintained a high reputation amongst their users.

Manufactured by

Sir W. H. Bailey & Co Ltd

ALBION WORKS, SALFORD, MANCHESTER.

The Human Element



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SIMPLE, OF COURSE, BUT SO ARE ALL THE REALLY BIG THINGS.

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BERRY TRANSFORMERS, in millions of Horsepower, are giving satisfactory service all the world over, their design and manufacture depending on 30 years' continu-ous and ever widening experience.

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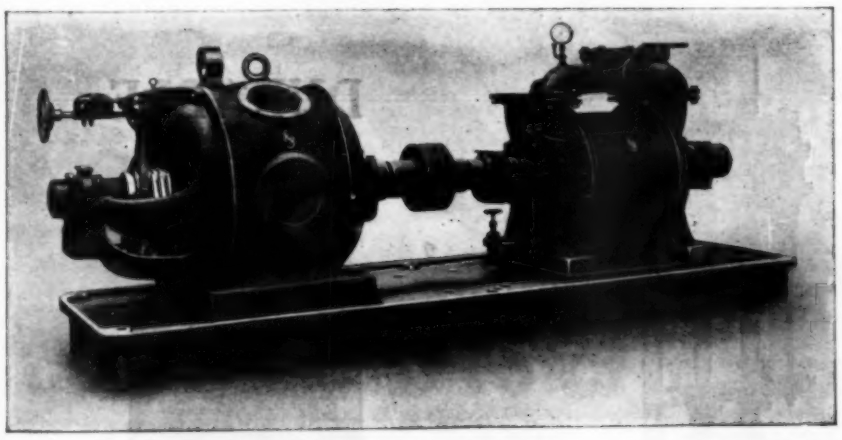
SIEMENS-SCHUCKERT
ELECTRIC PUMPS, COMPRESSORS & VENTILATORS FOR ALL PURPOSES



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Something New in Vacuum Pumps and Compressors.

ADVANTAGES:

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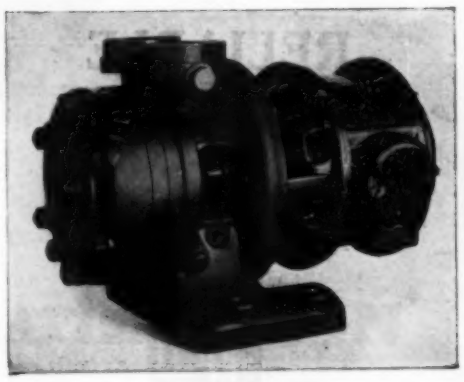
- Indifferent to Dust, Steam, High Temperatures and Liquids.
- Little wear and tear.
- Competitive Prices.
- London Stocks.

THE PUMP that requires little or no attention.

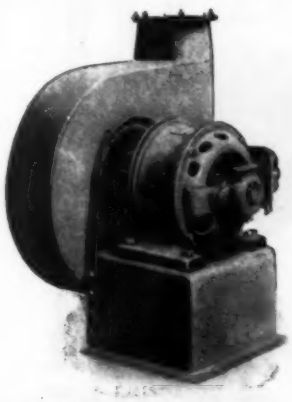
Reliable in Service.

High Efficiency.

Low Cost



ELECTRIC SELF-PRIMING CENTRIFUGAL PUMP FOR ANY LIQUID.



ELECTRIC FORGE BLOWER.

Something New in Pumps.

ADVANTAGES:

- Self-Priming even if suction pipe is empty.
- Suction Head approx. 25 feet.
- Deep Well Sets up to 100ft. Suction Head
- Little Wear and Tear even if liquid contains sand, etc.
- Electric Motor cannot be overloaded.

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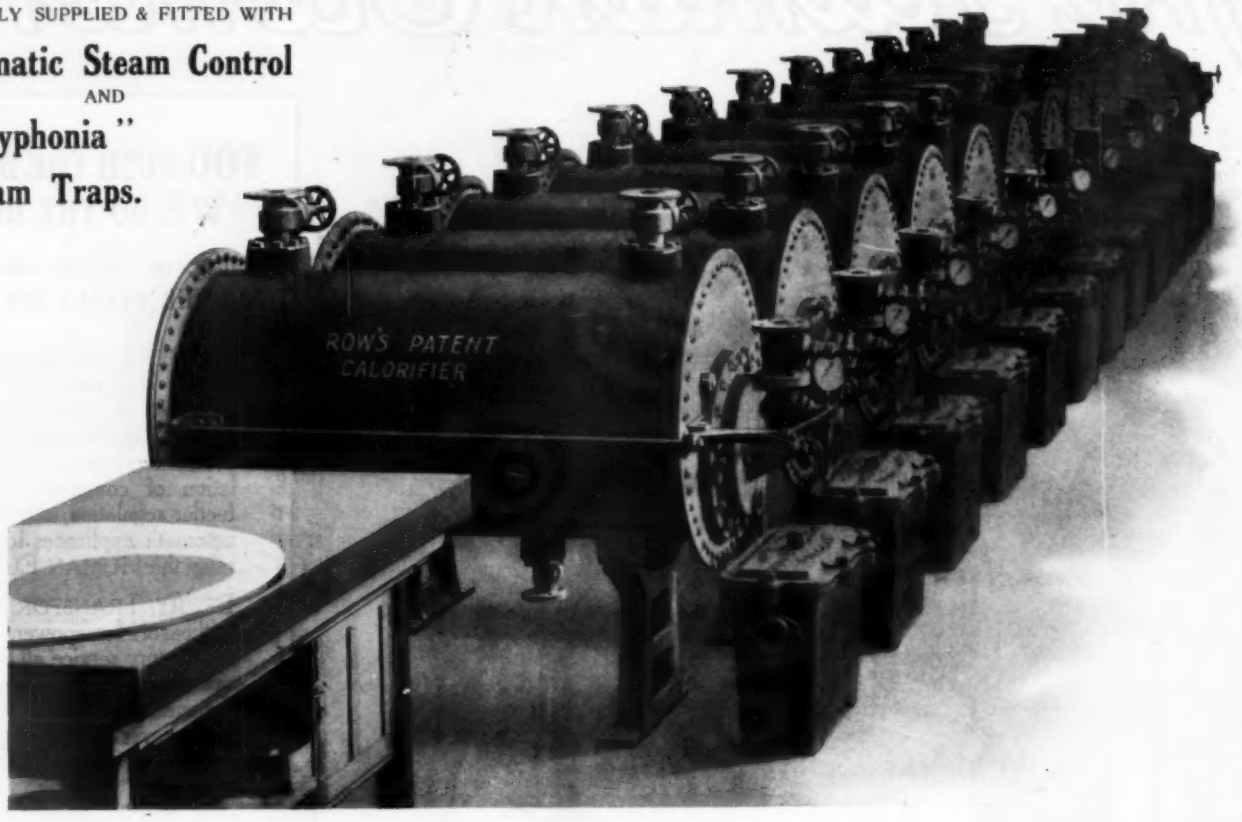

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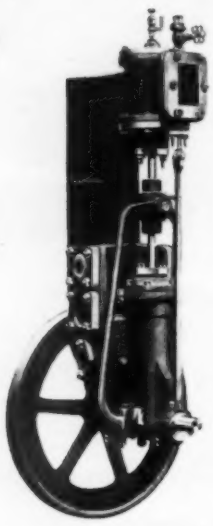
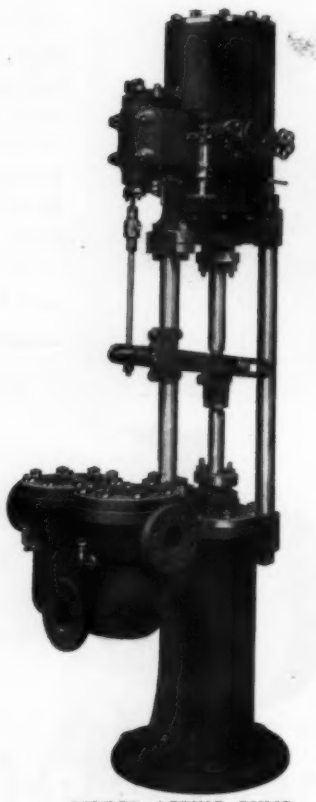


"MANCHESTER" DONKEY or WALL PUMP.



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Series R.P.V.

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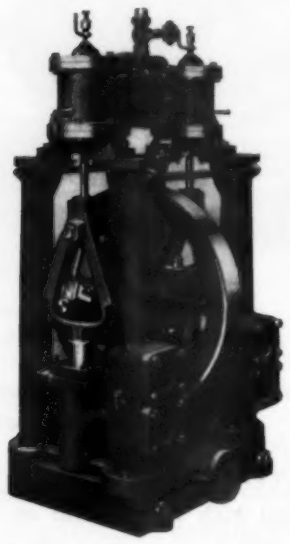

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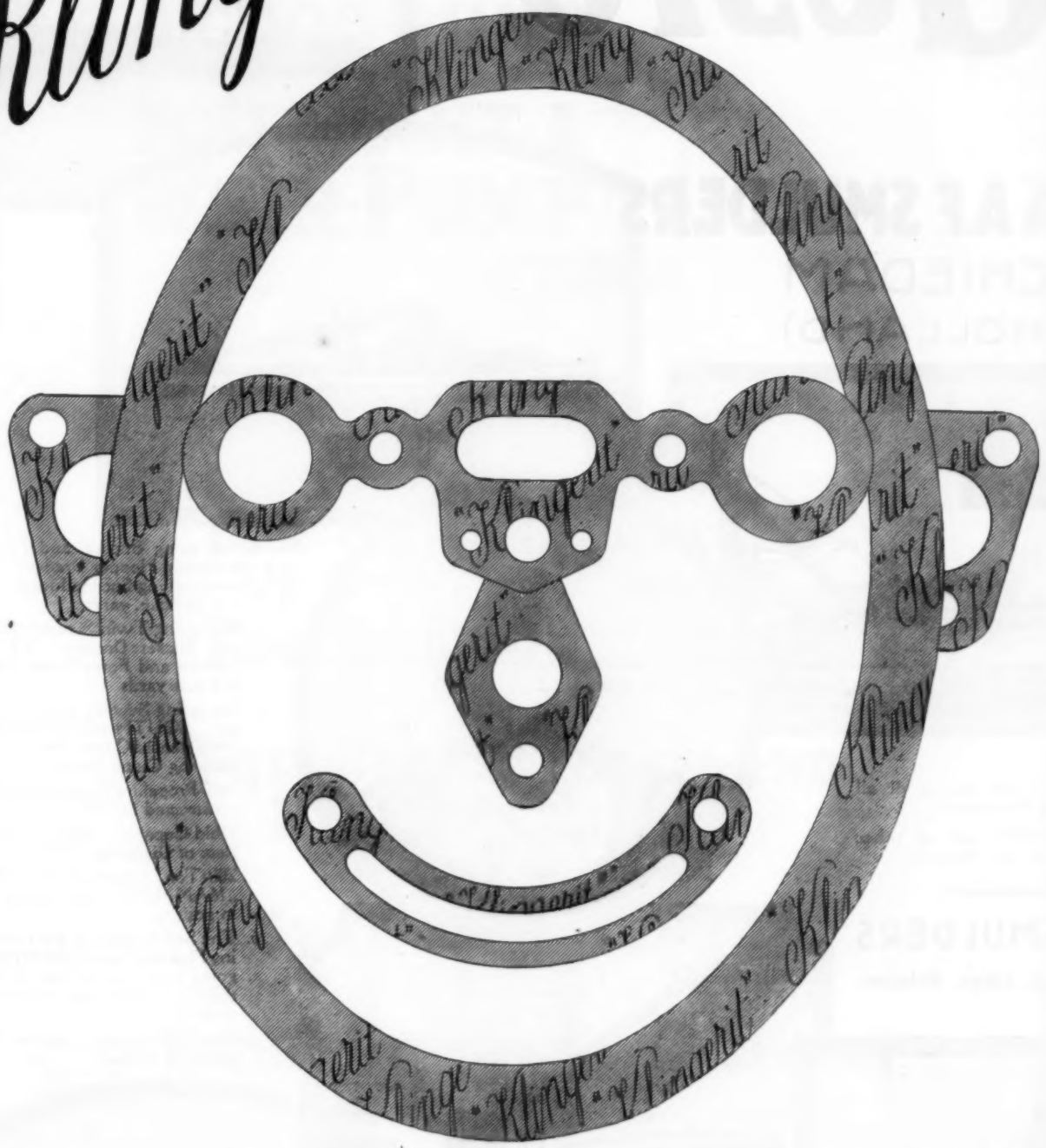

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DOES NOT VULCANISE.
WILL NOT BURN OR BREAK AWAY.
WILL WITHSTAND GREAT PRESSURES.

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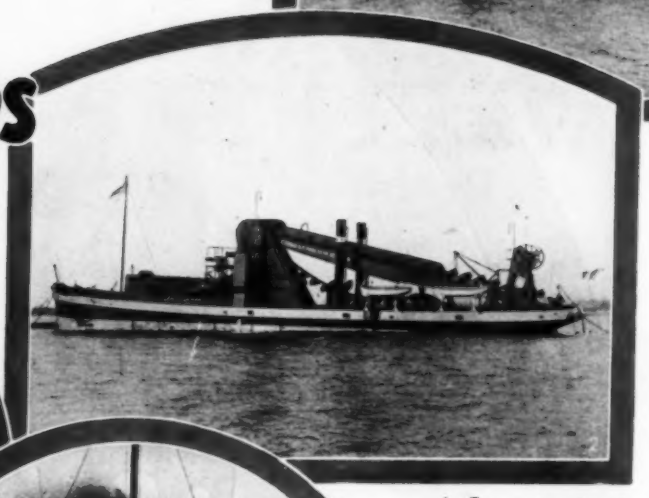

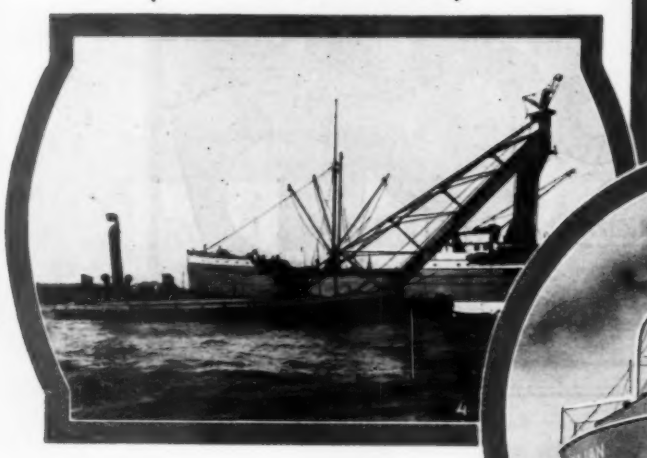

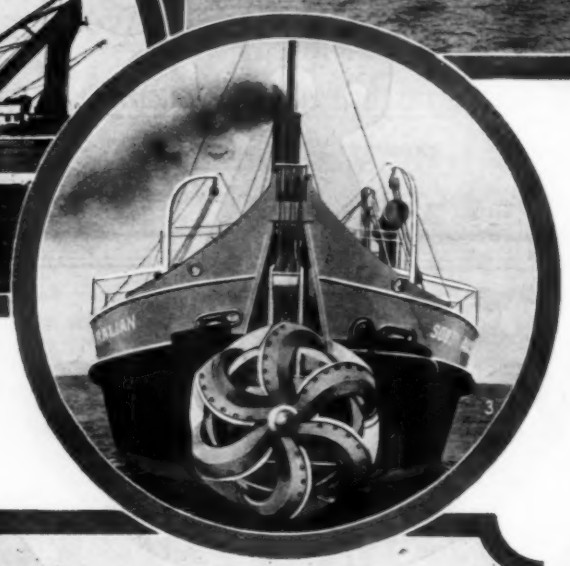

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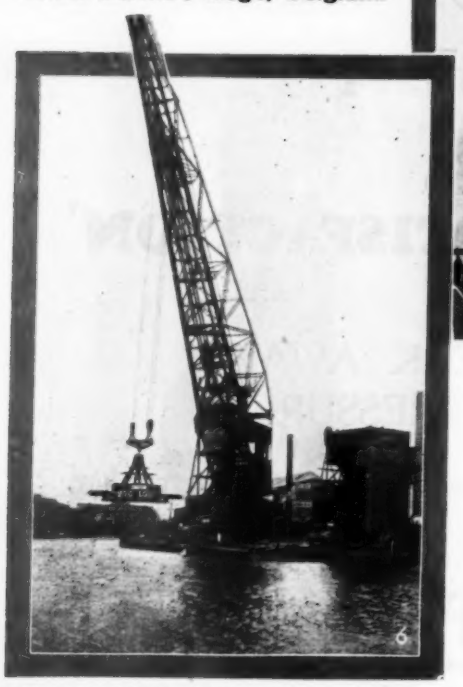

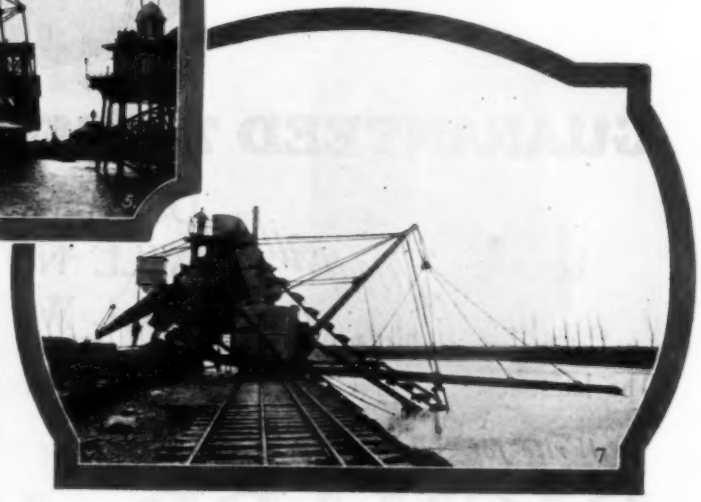

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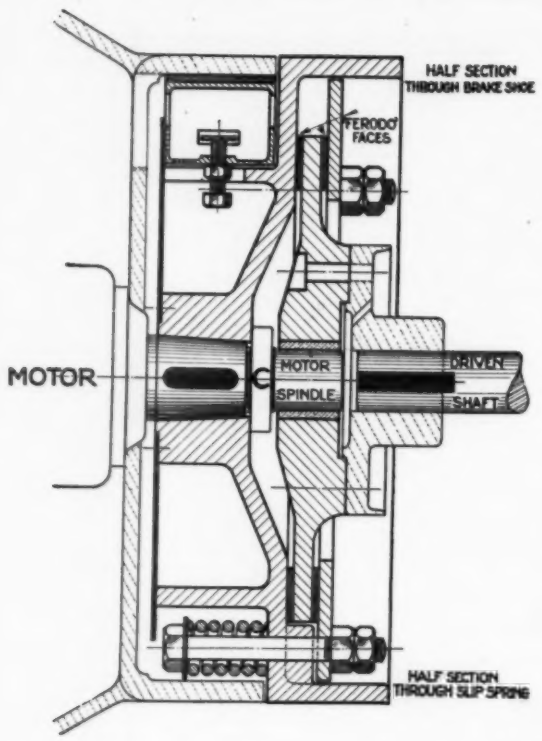

Section of a "Broadbent" Slipping Clutch Coupling.

"Broadbent"

SLIPPING-CLUTCH COUPLINGS

Combined with Centrifugal Speed-governing Brake.

These Couplings fully protect the motor in Two ways :—

(1) By the plate clutch slipping at any desired overload.

(2) By the Automatic Centrifugal Clutch acting as a brake on the motor in the event of it exceeding a predetermined speed, either by its own power or by the gravity lowering of the load.

Indispensable for Ship Winches and Slipways.

THOMAS BROADBENT & SONS, LIMITED,

HUDDERSFIELD.

The largest makers in the World of Centrifugal Clutches.

Crossley Installations the World over—

65% SAVED

WHEREVER a power user has changed over to Crossley Installations a saving on running and upkeep costs has been recorded—in the letter quoted below, for example, the saving is of such proportions as to afford considerable satisfaction to user and maker alike. Messrs. J. & W. H. Duncan, Millers and Merchants, Belfast, writing on May 22nd, 1925, say :—

> *"We are pleased to be able to inform you that the 'Crossley Cold Starting Heavy Crude Oil Engine' which we installed about 10 months ago has been quite satisfactory. We find it very reliable and economical. Taking into account the cost of Crude Oil and Lubricating Oil we are effecting a saving of over 65%. We start the engine from dead cold each morning with unfailing regularity, and it only takes a few moments to start.*
>
> *"We are also highly pleased with the simple design and construction of the Engine, and the extreme steadiness of the drive."*

The above saving of more than 65% is over Electric Motors at the present cost of electric current for power purposes in Belfast, i.e., 1¾d. per unit.

A striking tribute to the remarkable economy of Crossley Engines.

HEAVY-OIL ENGINES from 6 to 1,000 B.H.P.
CONVERTIBLE ENGINES to use either Oil or Gas, whichever may be cheaper at the time.
REFINED OIL ENGINES from 3 B.H.P. upwards.
GAS ENGINES from 4 to 5,000 B.H.P. and
SUCTION GAS PLANTS from 6 to 600 H.P. per unit.

OVER 100,000 ENGINES BUILT & SOLD.

CROSSLEY BROTHERS, LIMITED,
OPENSHAW, MANCHESTER.
Telegrams: Gasengine, Manchester. Telephone: City 4200.
London Office: 139-141, Queen Victoria Street, E.C.4.

CROSSLEY

HEAVY-OIL ENGINES

A 54

THE SERVICE IN THE ROPE

BRITISH made Steel is recognised as the highest grade produced, and, when the subsequent stages of working up into the finished product are carried out with British workmanship, the result is

THE FINEST IN MATERIAL
and
THE FINEST IN FINISHED
MANUFACTURE.

WHITECROSS WIRE ROPES are so manufactured of British made Steel, worked up by British Workmen and Staffs, all life-long specialists in producing

THE HIGHEST GRADE
STEEL WIRE ROPES.

Whilst, in Special Siemens Acid Steel, Swedish Pig Iron is used, with British Hematite Iron, this combination is carried out to our analysis and Specification entirely in British Steel Works by British Labour.
Every stage of manufacture, therefore, from raw materials to the finished Rope, is under uniform control—

ENTIRELY BRITISH.

Standardisation in Heat Treatments, Cold Drawing, Chemical and Physical Tests, is based upon the most vigorous and exacting methods ever known—

ENTIRELY BRITISH.

Finished design is to ALL Specifications—

BRITISH.

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WARRINGTON, England.
(Established 1864).

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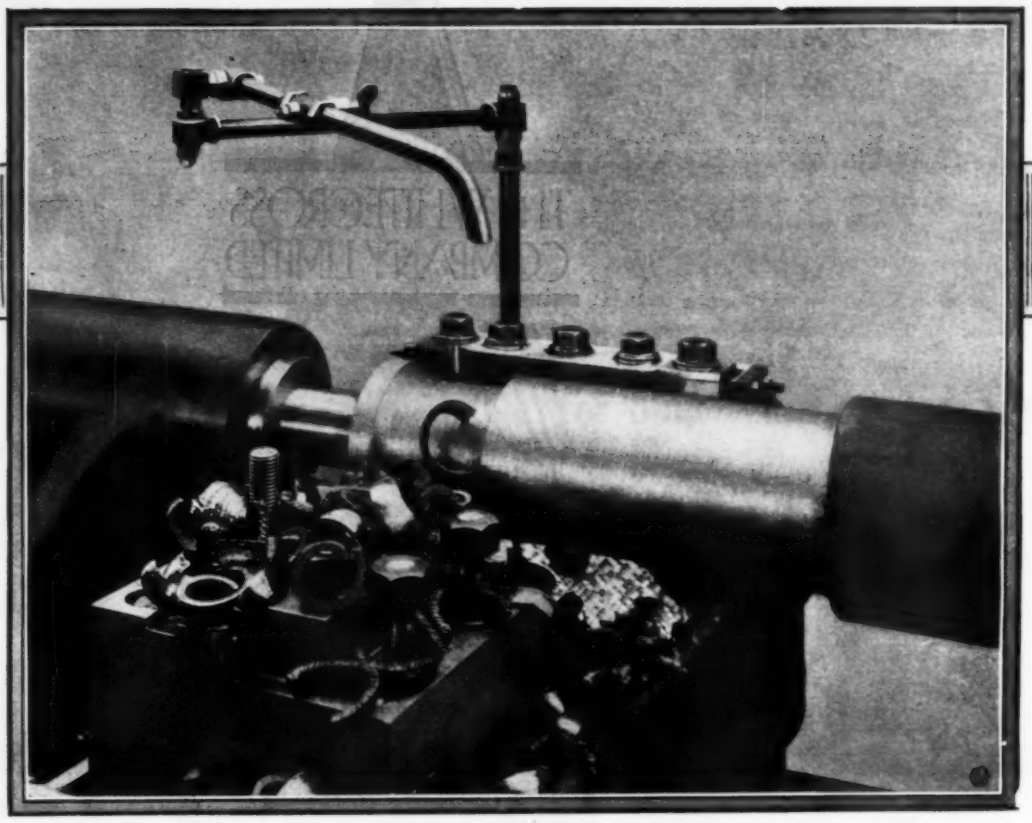


A Remarkable Tool Steel

A·W "SUPER TYR"

"A.W. Super TYR" Circular Cutter, Cutting and partly finished Axle.

THIS new A.W. Tool Steel has been produced to handle the higher tensile steels now coming into use.
It is remarkable for its high cutting speed, long life and freedom from distortion in use.
We illustrate one test conducted on our stand at Wembley, 1924.
To make the test exceptionally severe, an old nickel chrome axle was chosen with the following result :

WEIGHT OF CUTTING	9 lbs. 15 ozs.
WEIGHT OF CUTTER	9 ozs.
DISTANCE OF TRAVEL at 3/32in. FEED	5in.
TIME OF TRAVEL	62½ seconds.

The other test was conducted by one of the most important English Railway Shops and was as follows :—

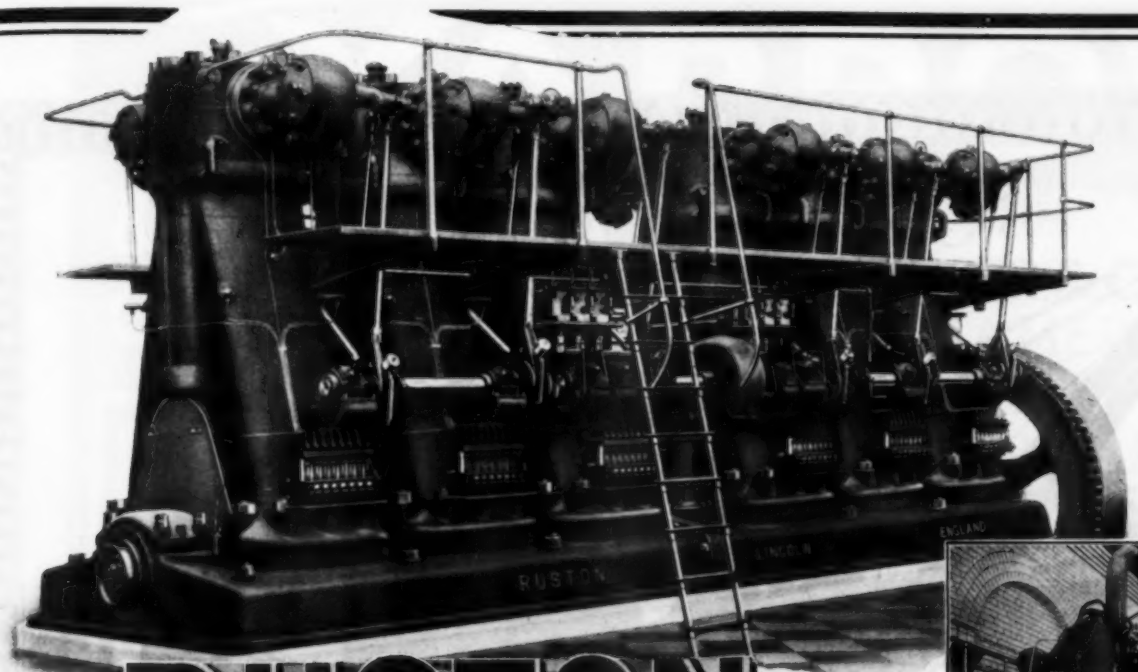
NUMBER OF WHEELS TURNED	600 pairs.
TENSILE OF TYRES	42-48 tons per sq. in.
TOOLS RE-GROUND	8 times.
WEIGHT OF TOOLS, NEW, per pair	4 lbs. 8 ozs.
WEIGHT OF TOOLS AT END OF TEST, per pair	4 lbs. 11 ozs.

"A.W. Super TYR" is undoubtedly the finest tool steel available for machining brake hardened tyres, stainless steel turbine blades, or any of the higher tensile steels.
We shall be pleased to quote you either for "A.W. Super TYR" or for cutters made from it.

SIR W. G. ARMSTRONG, WHITWORTH & CO., LTD.,
OPENSHAW WORKS, MANCHESTER.
London Office :
8, GREAT GEORGE STREET, WESTMINSTER, S.W.1

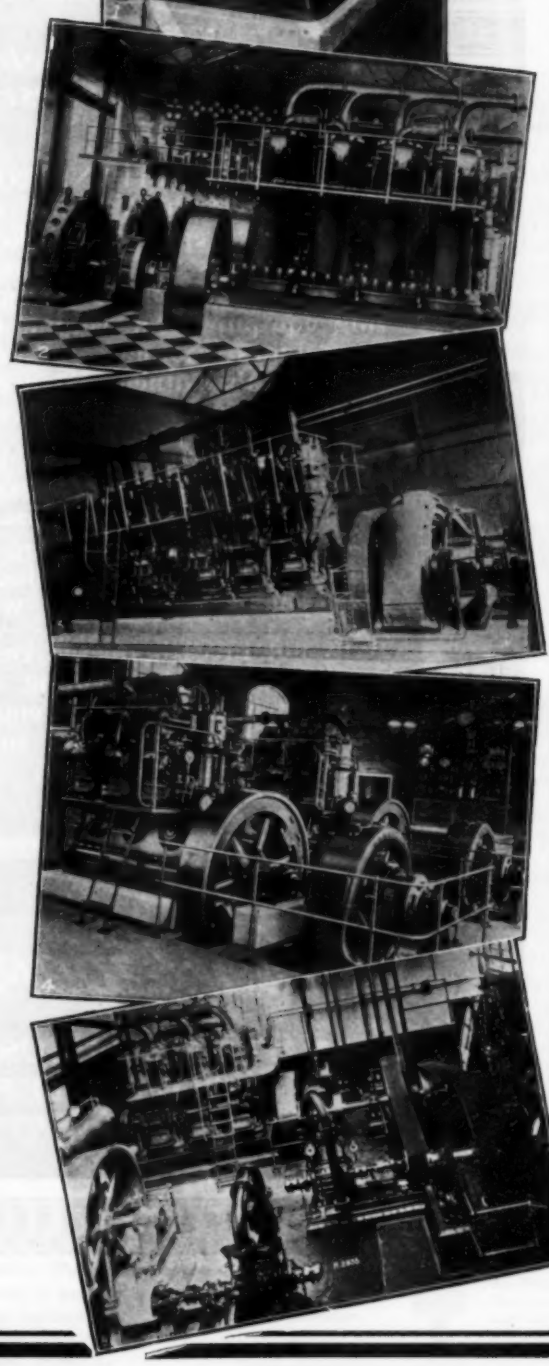
Telephone : Victoria 4010 (6 lines). *Code :* Bentley's. *Telegrams :* "Zigzag, Parl, London."

E.P.S. 292



RUSTON

OIL ENGINES



Some Installations Illustrated:

1. A 250 Kw. Set in a Municipal Power Station for which a SECOND Ruston Vertical Oil Engine has now been installed.
2. An Overseas Electric Light and Power Station, comprising Three Ruston Engines, each of 440 B HP., direct coupled to Alternators.
3. A Unit of 660 B.HP. at a Municipal Power Station where Ruston Cold Starting Oil Engines totalling 2000 B.HP., are installed.
4. Two Ruston Units of 165 B.HP. at another Municipal Power Station.
5. A Ruston Vertical Oil Engine of 250 B.HP. One of 6 Ruston Oil Engines, totalling over 1000 B.HP., at a Waterworks undertaking.

Repeat Orders speak for themselves!

May we put you into direct communication with users of Ruston Engines?

Their Experience is our Recommendation!

A List of Users, Publication A4861, will be sent on request.

RUSTON & HORNSBY LTD., LINCOLN.

Telegrams: "RUSTON, LINCOLN." *Telephone: LINCOLN 580.*

LONDON: IMPERIAL HOUSE, 15-17-19, Kingsway, W.C. 2.

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BIRMINGHAM: Chamber of Commerce Buildings, 95, New St.

Upper picture: Repairing broken member of crane under-carriage by A-L Oxy-Acetylene Welding Equipment (Dissolved Acetylene).

Lower picture: A-L Oxy-Acetylene Cutting Blowpipe, in use in a ship-breaking yard.

Welding Equipment

(Oxy-Acetylene, Electric Arc, and Electric Resistance)

A-L OXY-ACETYLENE EQUIPMENT is extensively used in big engineering works for repairing broken forgings and castings and restoring defective parts, whilst we are continually supplying equipment for welding sheet metal containers, motor car silencers and innumerable other instances of structural and manufacturing work.

Our experience of welding is probably unique. We supply Oxy-Acetylene Equipment for all purposes as well as Electric Arc Welding Sets, and Electric Resistance Welding Machines for spot, seam and butt welding.

Why not investigate the cost-reducing possibilities of welding on your regular work? Our engineers are at your disposal; you may consult them without obligation.

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PASSENGER & CARGO STEAMERS
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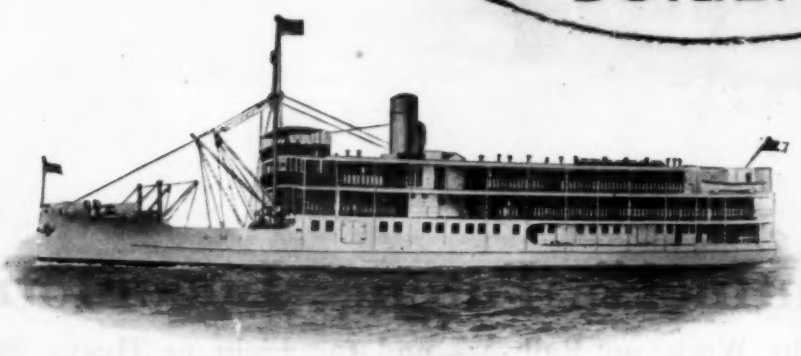

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WITTON BIRMINGHAM

OUR PROTECTED TYPE
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REFRIGERATING PLANT.
PETER BROTHERHOOD, LTD.,
PETERBOROUGH.
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NETHERLEE ROAD, CATHCART.
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MANNING, WARDLE & CO., LTD.

BOYNE ENGINE WORKS, LEEDS.

Makers of Locomotive Engines for any width of gauge and various purposes. Also makers of Internal Combustion (Petrol) Locomotives. Materials and workmanship of the best quality. Tank Engines up to 18in. cylinders, on four or six wheels, always in stock or in progress. Specifications, Photos and Prices on Application, and special designs sent on receipt of particulars of requirements.

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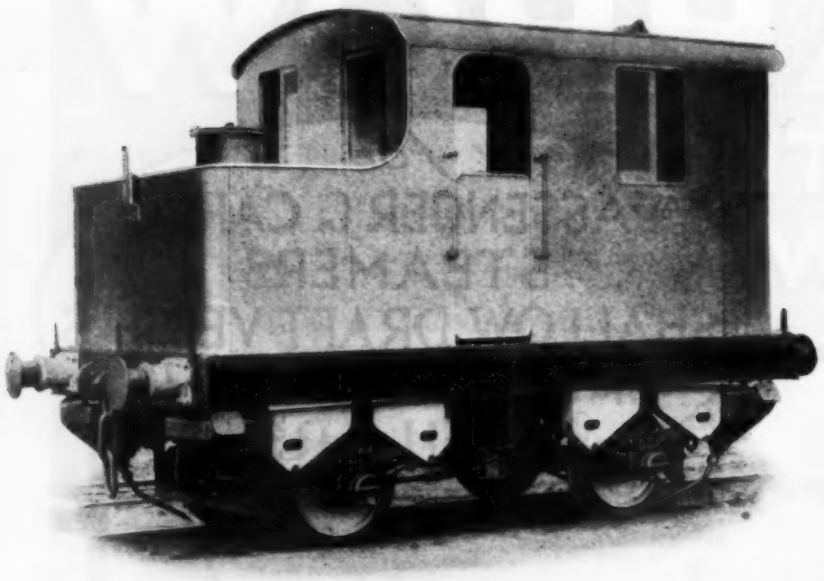
TEST-PUMPS, &c.

Self-Recording Instruments for Pressure, Temperature, and Speed.



Locomotive Type C.E.
Weight in running order
20 tons.

"Sentinel" Patent Locomotives.

For Light Work on Railways and for Light or Heavy Shunting.

IN the design of "Sentinel" Patent Locomotives the fullest use has been made of advances in steam engineering, and the results are revolutionary.

The Coal Consumption is reduced by at least **50 per cent.**; actual tests in work showing the following results :—

On Heavy Shunting, reduced from 25 cwt. to 8¼ cwt. per day.
On Medium Shunting, reduced from 15 cwt. to 6½ cwt. per day.
On Light Shunting, reduced from 6½ cwt. to 3 cwt. per day.
On Light Passenger Traffic, reduced from 33 lbs. to 8 lbs. per mile run.

Water Consumptions are reduced proportionately, with the result in some cases that the water tanks hold enough for two days' work in shunting, or for a straight run of up to 60 miles.

The Consumption of Oil and Stores is greatly reduced by the fact that the parts run in oil baths, and oil is not wasted by dripping from the open motion work used in the old style locomotive.

Repair Costs, which are such a large factor in the small locomotive of ordinary design, are reduced to much less than 50 per cent. Apart from the engine and boiler, which are dealt with later, there is nothing to wear except the wheels and axles, and these are not only working under much less arduous conditions, but renewals are simply and cheaply effected—indeed any part, including the engine and boiler, may be overhauled in a few hours.

A saving of over 50 per cent. is made in the time required to raise steam in the morning, and oiling and general attention show an equal reduction. The capacity to move an inch or two at a time, with certainty, saves largely in shunting times.

The Pulling Power or Tractive Effort of "Sentinel" Locomotives will come as a revelation to users of the old-fashioned type. This is due to the steady torque, reducing the tendency to slip to one-ninth that inherent in the usual type. The "Sentinel" leans against its load as a horse does, and smoothly and powerfully starts up a train 25 per cent. greater than that started by an ordinary locomotive of equal weight.

Steady Running at High Speeds is inherent in the design of "Sentinel" Locomotives, for the small amount which the engine is out of balance is in the vertical plane, and being above the bearing springs it hardly affects the loading of the wheels on the rails. There is no tendency towards nosing, such as is unavoidable in the ordinary design of locomotive, and both top and flange wear on the rails is greatly reduced.

The Patterns of "Sentinel" Locomotives so far made number three, and each is the subject of world-wide patent applications.

The Eighty Horse-power (Type B.E.) has a short wheel base of 41in. The Engine is behind, and the Boiler before both axles. This type is made for gauges from 24in. to metre, and in weights of Six and Ten Tons.

The Hundred Horse-power (Type C.E.), as illustrated above, has wheel bases either of 72in. or 102in., and is made for all gauges from 36in. to 5ft. 6in., in weights of from Ten to Twenty-five Tons. It may be geared to suit the duties required for maximum speeds up to 40 miles an hour or more. For heavy shunting work Type C.E.G. the gear may be arranged for maximum speeds as low as ten miles an hour, when the Tractive Effort is enormous.

The Two Hundred Horse-power (Type D.E.) has a wheel base of 72in. or 102in., and is made for gauges from 36in. to 5ft. 6in., in weights from Twenty to Thirty-five Tons. It also may be geared for any speed up to 40 miles, or any drawbar pull required up to 8½ tons (Type D.E.G.).

Where specially light axle loads are required, two locomotives of either Type C.E. or D.E. may be articulated with the boilers so placed and the controls arranged as to be easily handled by one driver. Then the range extends up to "Four Hundred Horse-power," using nothing but standardised units. These **Articulated Locomotives,** unlike Types B.E., C.E., and D.E., are not built to stock.

A new element has been introduced into the building of locomotives, as an inspection of our designs shows. Any power up to 400 horse-power is built from a few sizes of thoroughly well proved units, which are manufactured in quantity under rigid inspection in a highly specialised plant. Working under our patents, which we believe cover all the practicable combinations under this new method, we can :—

Make Locomotives of an efficiency and durability not hitherto known, and sell them at strictly competitive prices.

Use only thoroughly tested units of proved reliability.

Keep in stock parts suitable for combining into a Locomotive for any gauge or for any tractive effort.

Supply thoroughly interchangeable spare parts from stock at surprisingly low prices.

This is the twelfth of a series of twelve articles appearing weekly touching on various phases of Railway work. A booklet comprising the series will be sent on request to Railway officers who are interested.

The Sentinel Waggon Works, Limited,

Railway Department, Iddesleigh House, Caxton Street, Westminster, London.

THIS illustration shows a Sullivan W.K. 312 Portable Compressor in operation at Glasgow. Many of the largest contractors are finding that these machines constitute one of the most profitable investments they have ever made.

On the job!

WHERE Sullivan Portable Compressors are used no time is wasted from mechanical breakdown. They are the most reliable machines on the market. The model shown here has an air capacity of 110 cubic feet, with two compressor cylinders. The practically vibrationless operation of Sullivan Compressors reduces wear and tear to an absolute minimum. They are handy in size, being the smallest and lightest of any compressor of equal capacity; two men can move them easily. Solid one-piece cast steel frames are used. They are gearless and unusually economical on fuel. Send for catalogue No. 2577 N.

Showing Sullivan Concrete Breaker, type D.B. 221, and Sullivan Hammer Drill, type D.P. 321.

SULLIVAN
Machinery Company

(Established 1850).

SALISBURY HOUSE, LONDON WALL, E.C. 2.

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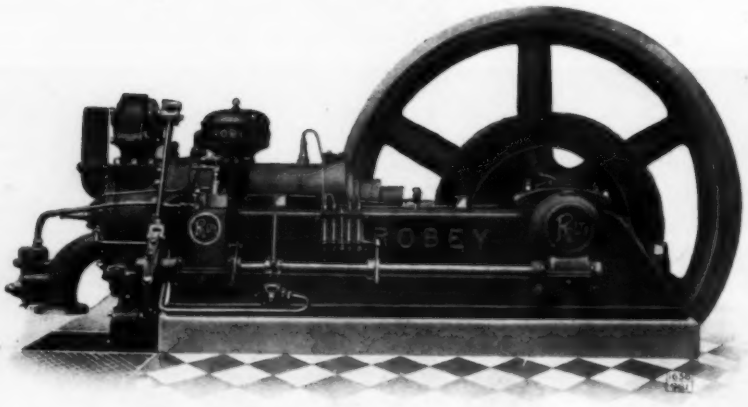
ROBEY

(Oil Engine Makers since 1891).

ECCENTRIC
VALVE
GEAR



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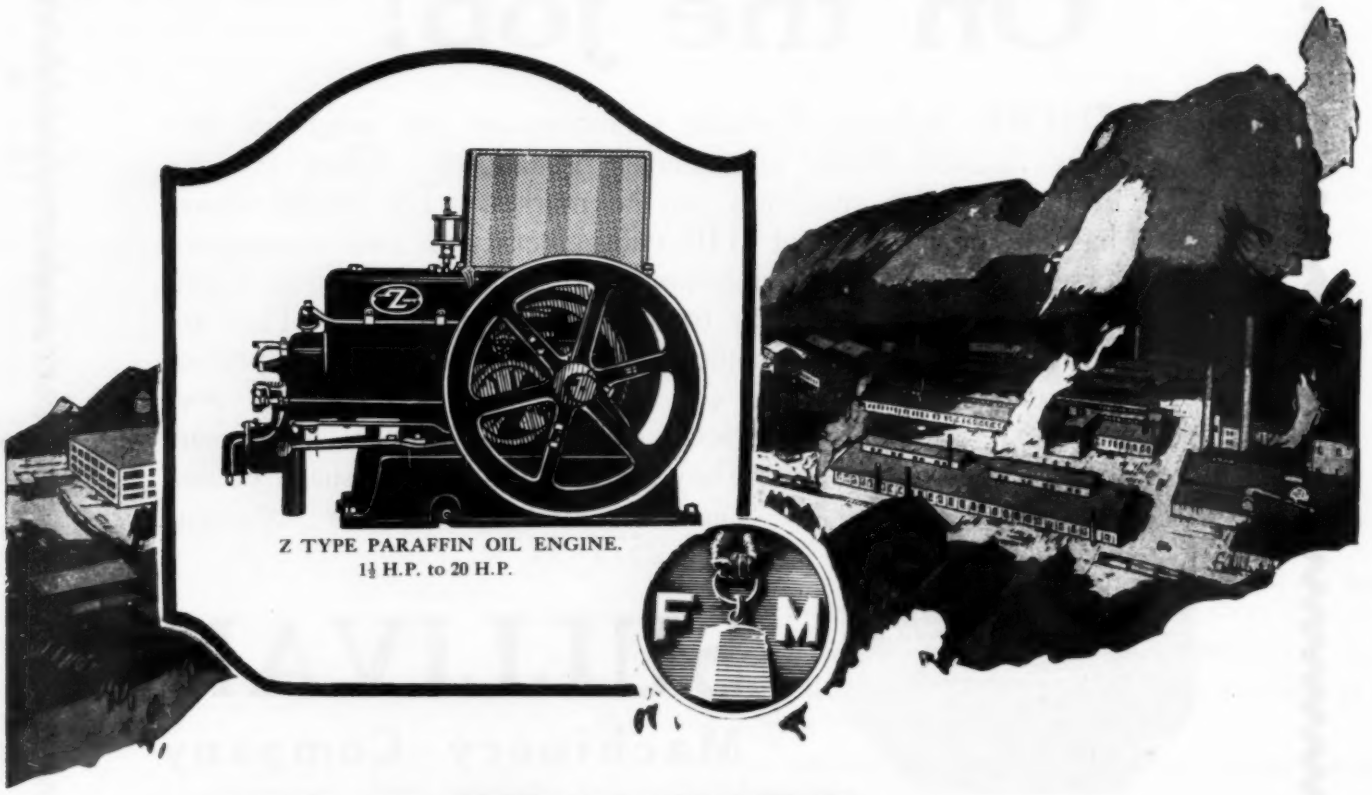
MADE LIKE A STEAM ENGINE :: RUNS LIKE A STEAM ENGINE

Works: LINCOLN. **LONDON OFFICES: 91, Queen Victoria St., E.C.4.**



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1½ H.P. to 20 H.P.

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FOR CONCRETE MIXERS AND HOISTS.
BRICK MAKING MACHINERY
SAND AND GRAVEL PLANTS
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SUPPLIED FITTED WITH
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ROBERT HUDSON LTD

"We are able to make better time and reduce our loading costs by using your equipment."

The above extract is from a letter which is given in full below. It is worth reading.

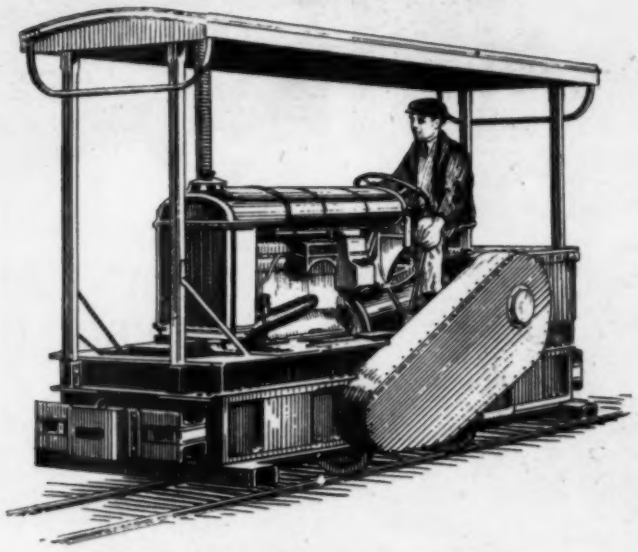
"The new Locomotive appears to be a splendidly designed machine and has probably saved the Company some £50 by being on the spot in time to handle the coal, owing to the breakdown of the haulage. To use the steam locomotive would have seriously hampered the stone delivery to the Mill. This kerosene locomotive went away from the start without a hitch, and has been doing 12 hours per day. Its performance so far is excellent.

"The new Trucks are in service, and are a superior design to the old ones. We are able to make better time and reduce our loading costs by using your equipment."

Here, also, is another unsolicited report from a user of the Hudson Paraffin Tractor:—

"The Tractor is working very satisfactorily indeed. It is in commission continuously from 6 a.m. on Monday mornings until 12 noon Saturdays, and up to now has worked in a most satisfactory manner."

It is worth YOUR while to investigate the merits of the Hudson Tractor.



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20 h.p. Paraffin Rail TRACTOR.

Expressly designed for rough work, it is extremely low in first cost, upkeep and fuel. It is always ready for work, can be stopped or started instantly and carries sufficient fuel for a whole day's work—it is the modern method of haulage.

HUDSON WAGONS are BRITISH made

and are unsurpassed for excellence of design and workmanship. Constructed of the best materials Hudson Wagons give satisfaction under the severest tests.

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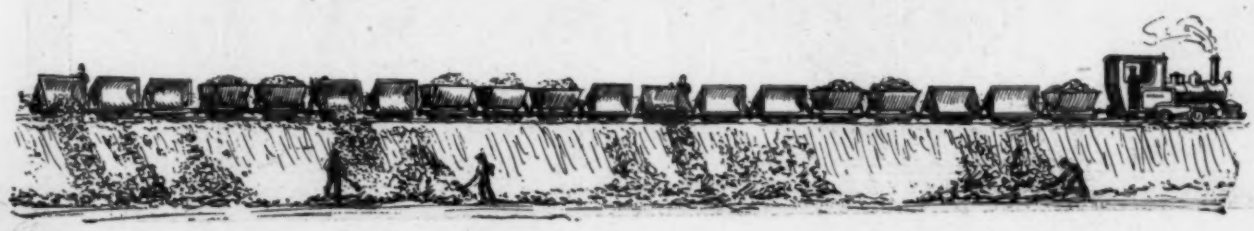

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STEEL CASTINGS

of every description up to 30 tons.

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Eminently suitable for Turbine Blades, and other parts of machinery working under similar conditions.

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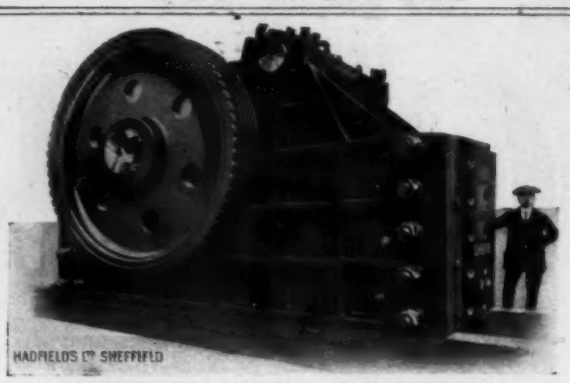
Specially suitable for Furnace. Components and all parts subjected to high temperatures

This steel is also of a non-corrodible character.

Messrs. Hadfields Ltd possess the sole patent rights for the sale and manufacture of these steels in the British Empire

All the resources of science are utilised in the Hadfield Research Department in the quest for better steels and the solving of Customers' problems.



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Size: 54in. by 36in. Weight 90 TONS.

Output: 150 to 200 Tons per hour.

All the Wearing Parts are of Hadfield's Patent "ERA" Manganese Steel.

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STONE BREAKING and ORE CRUSHING MACHINERY.

Ranging in Capacities from a few tons to 500 tons per hour.

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MANGANESE STEEL.

THE SUPREME MATERIAL

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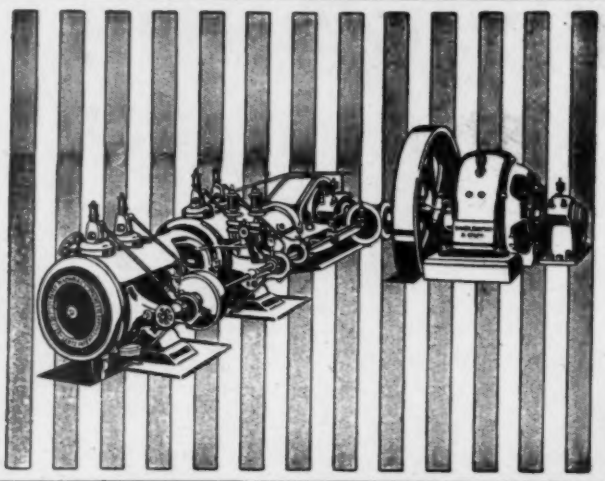

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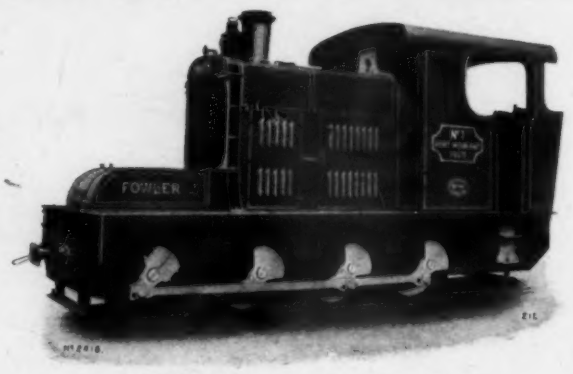

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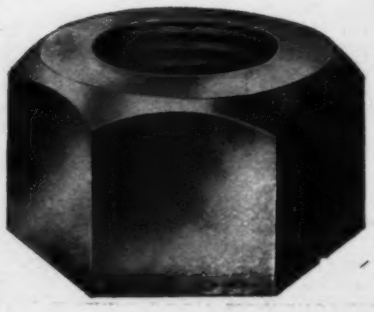

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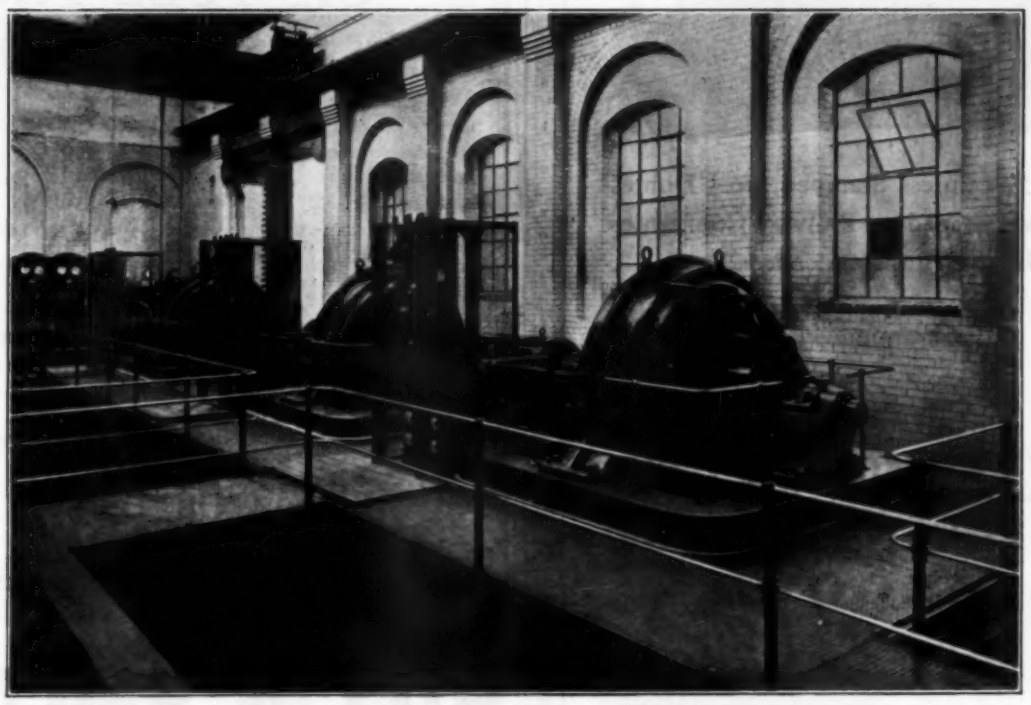

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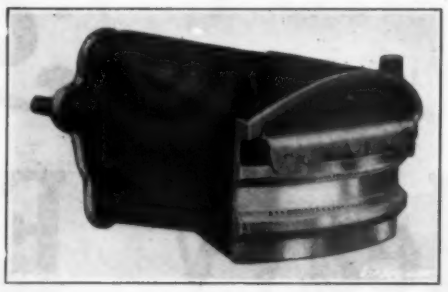

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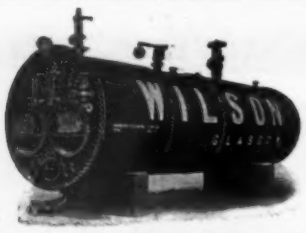

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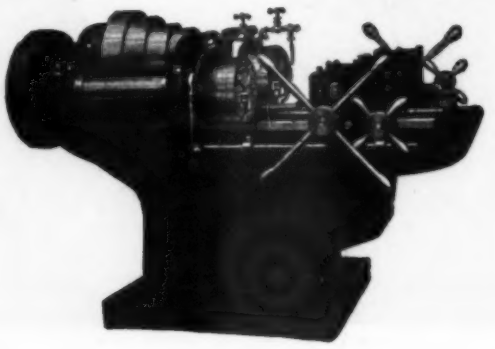

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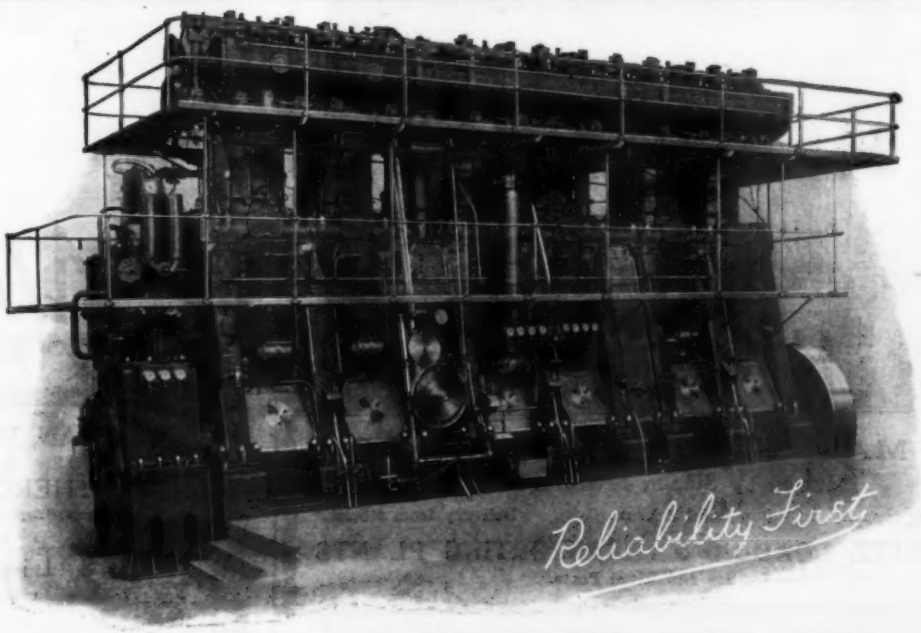

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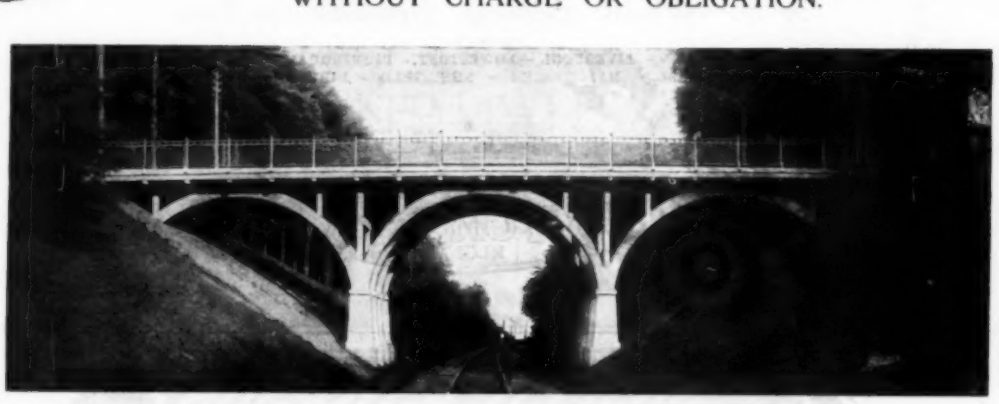

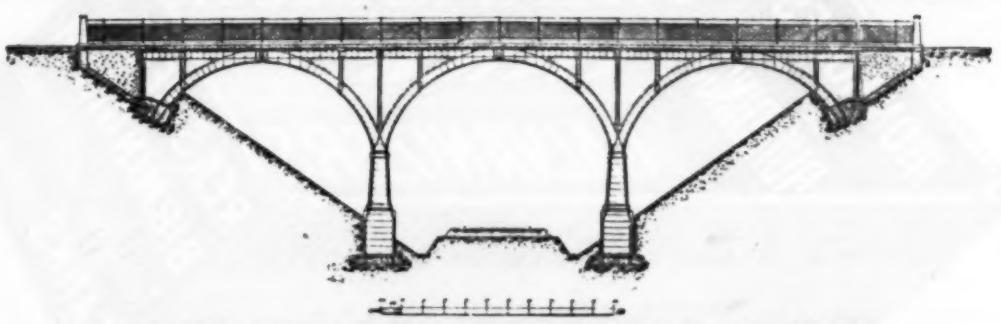

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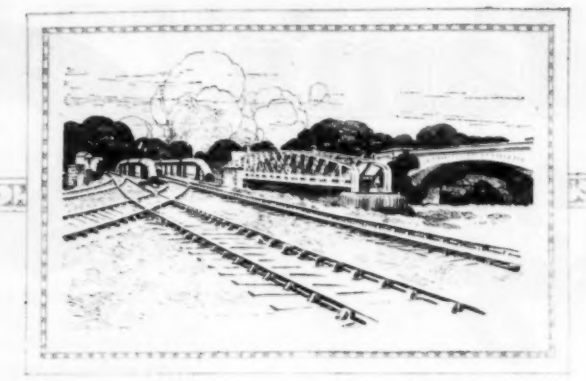

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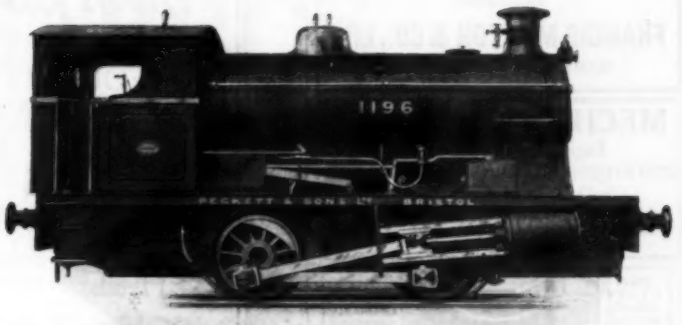

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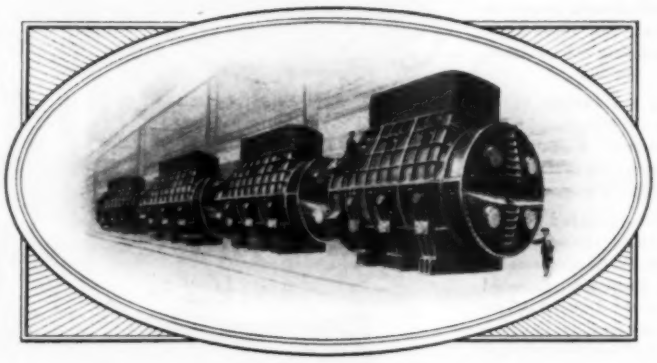

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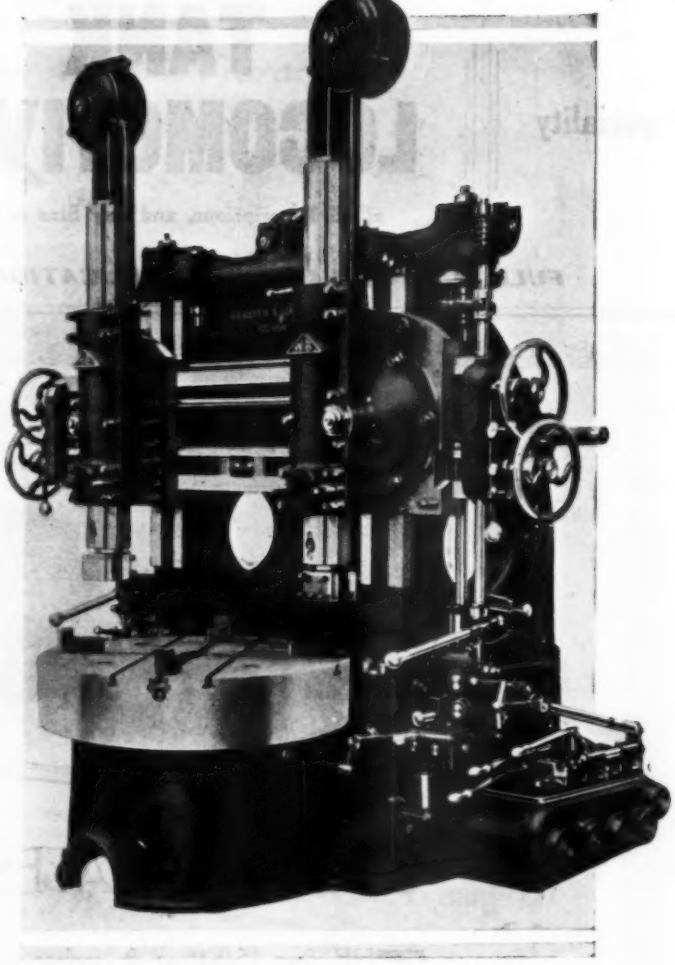

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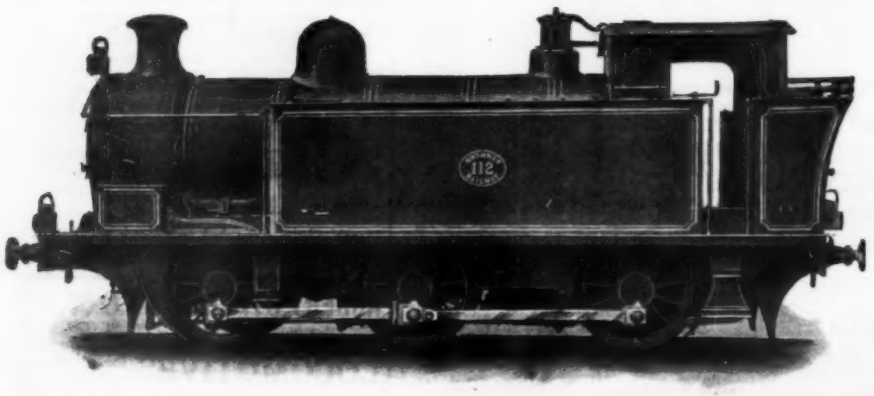

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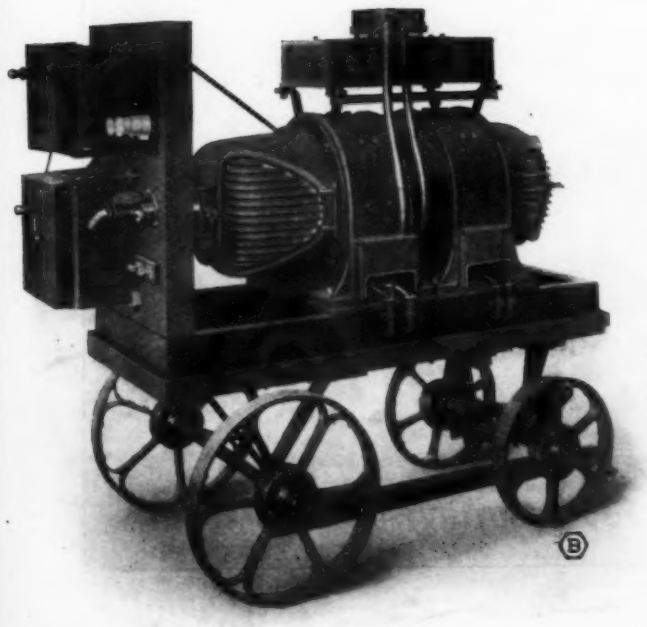

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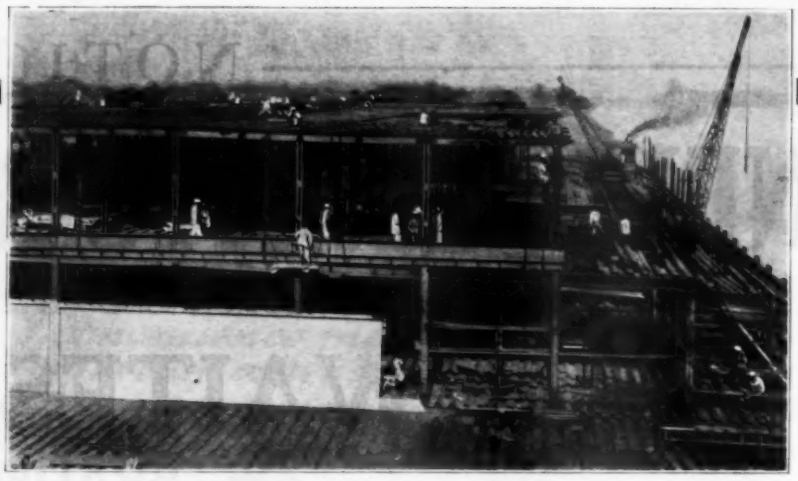

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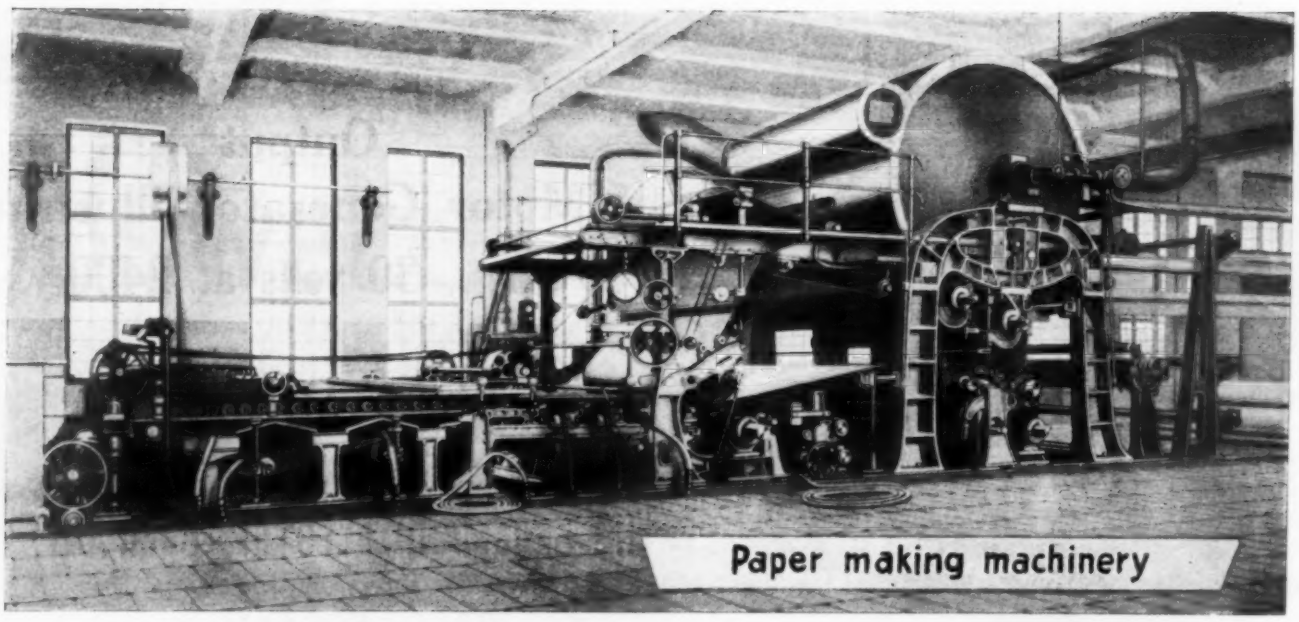

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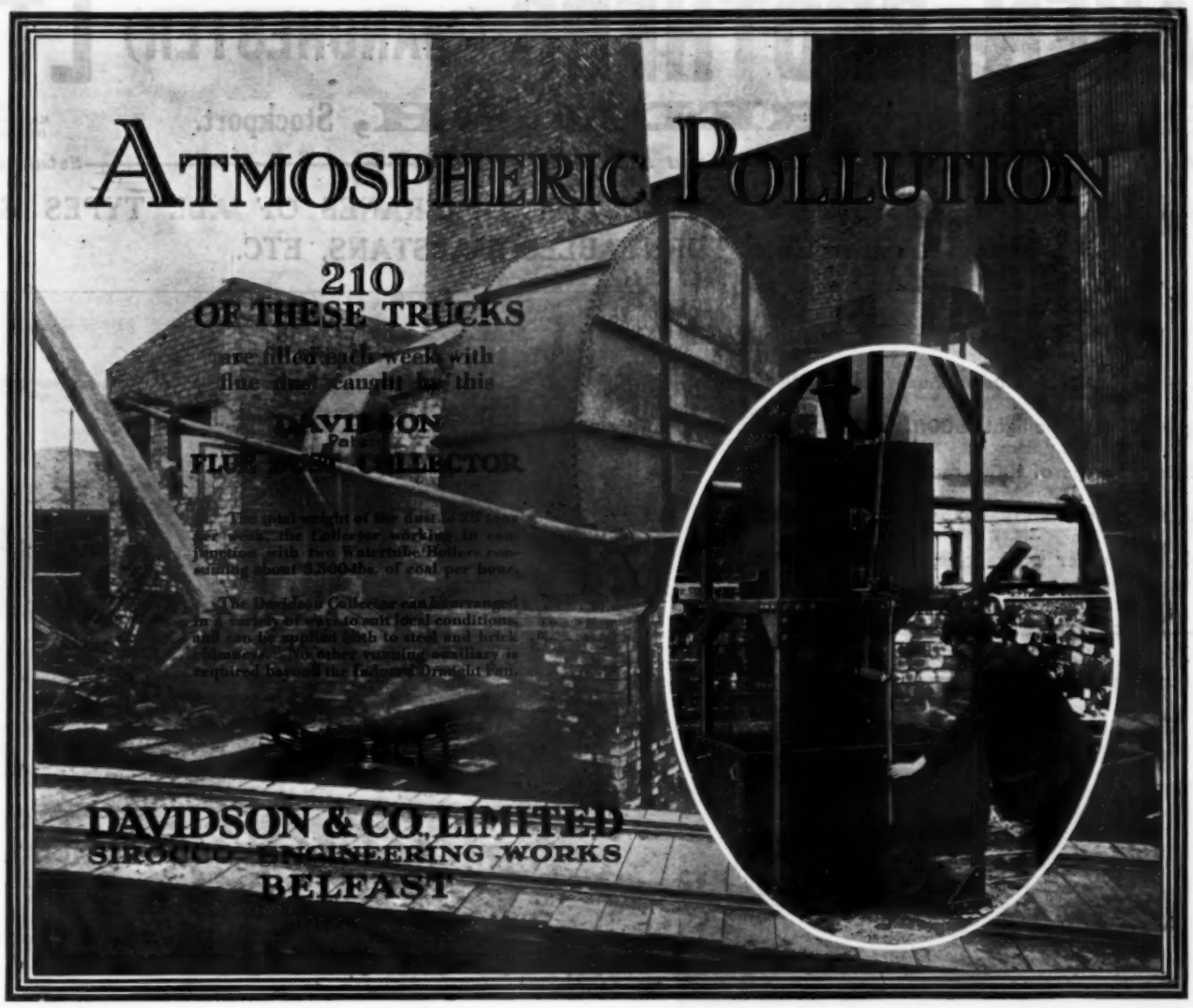

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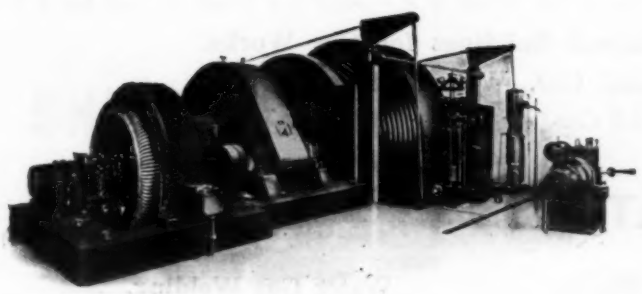

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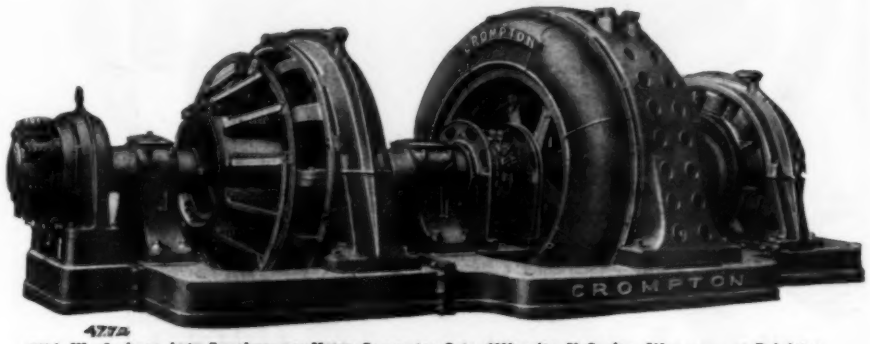

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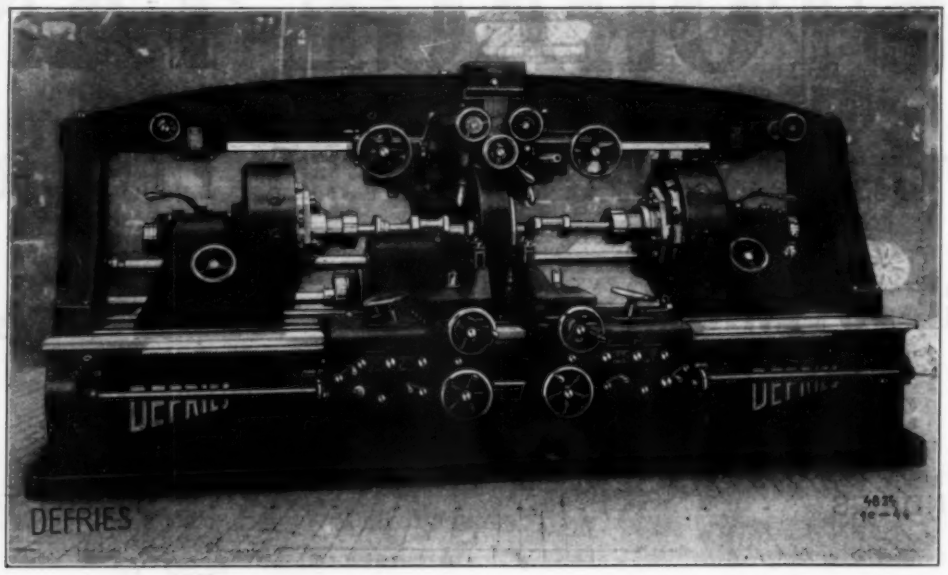

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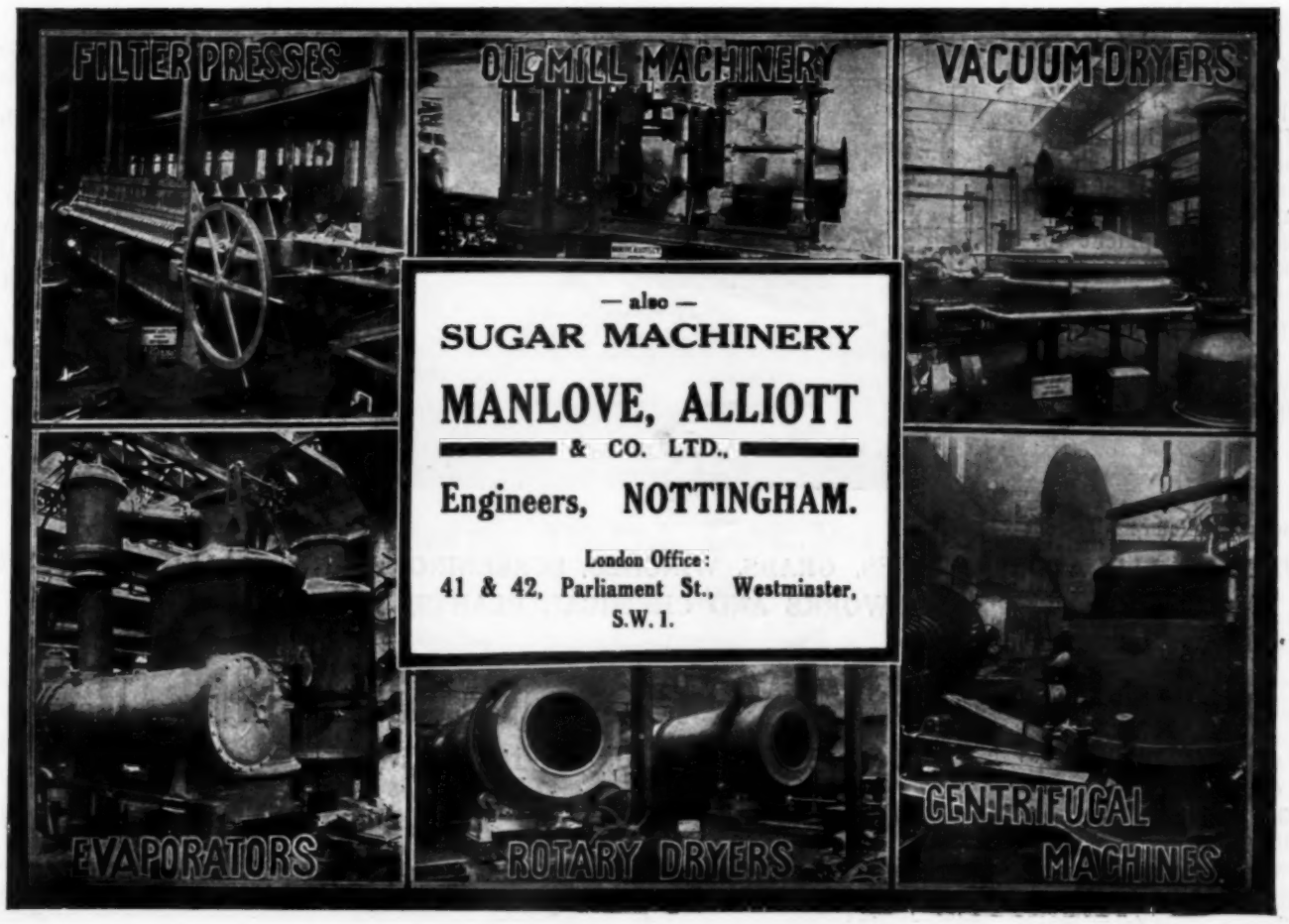

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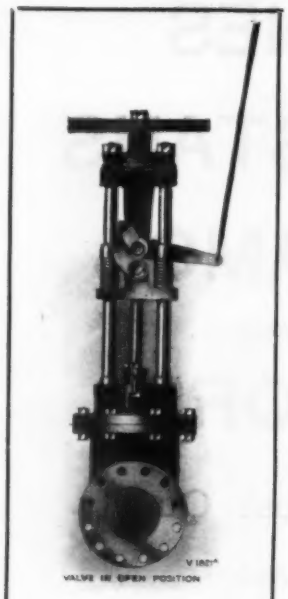

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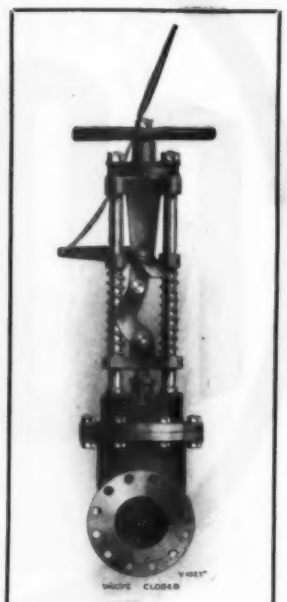

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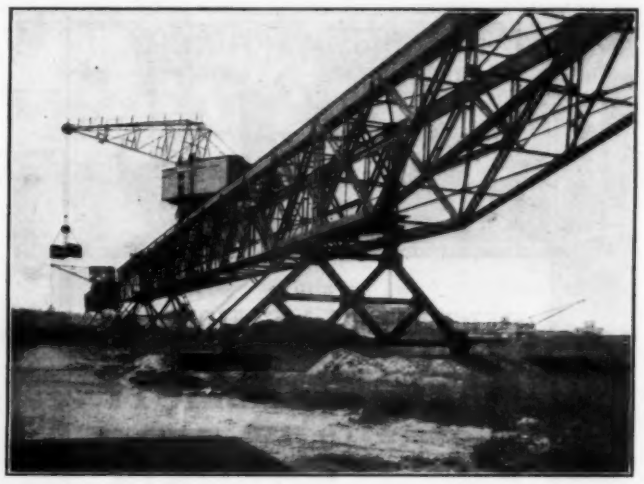

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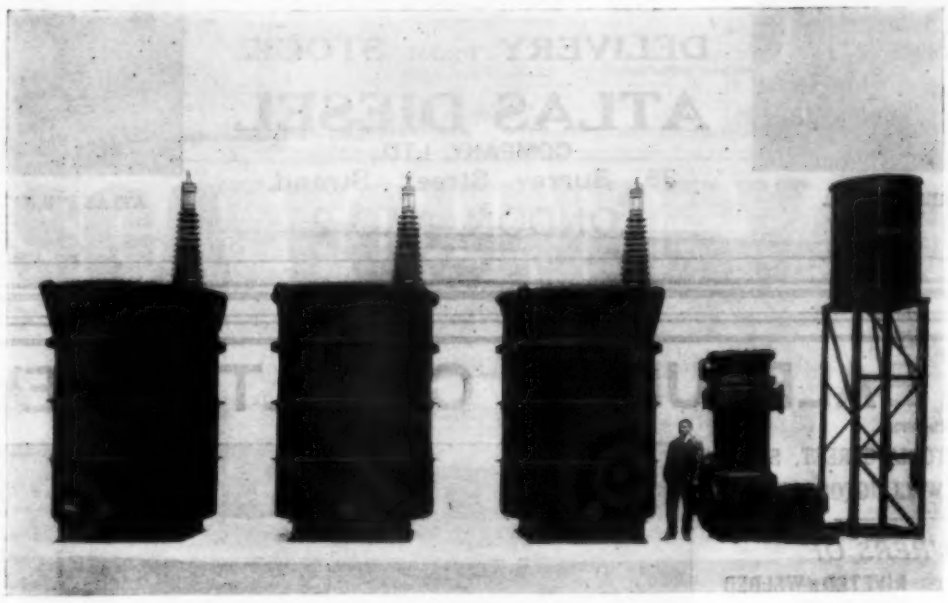

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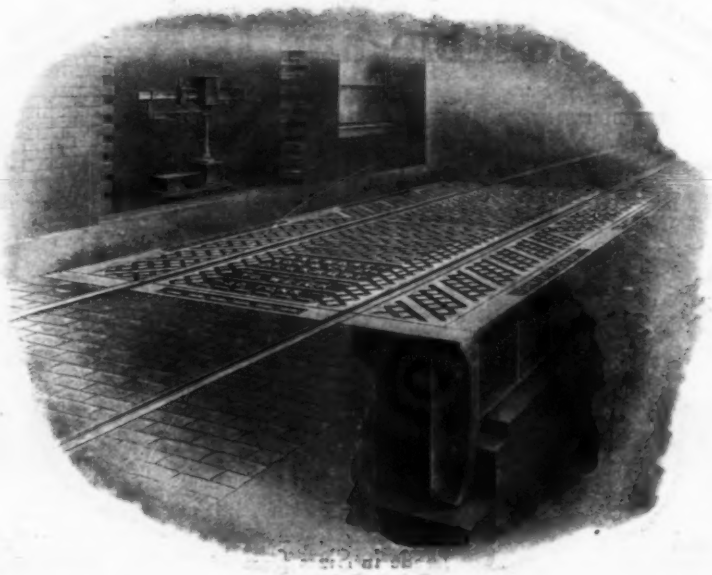

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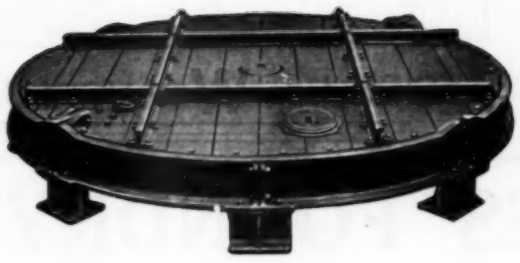

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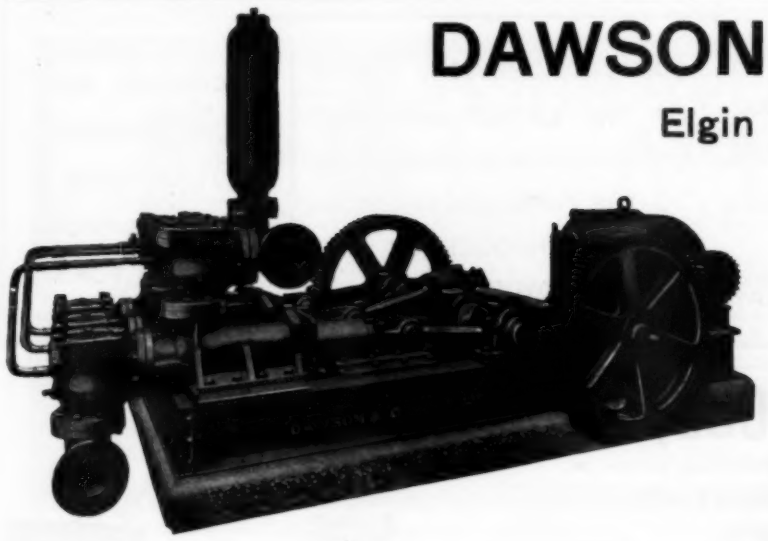

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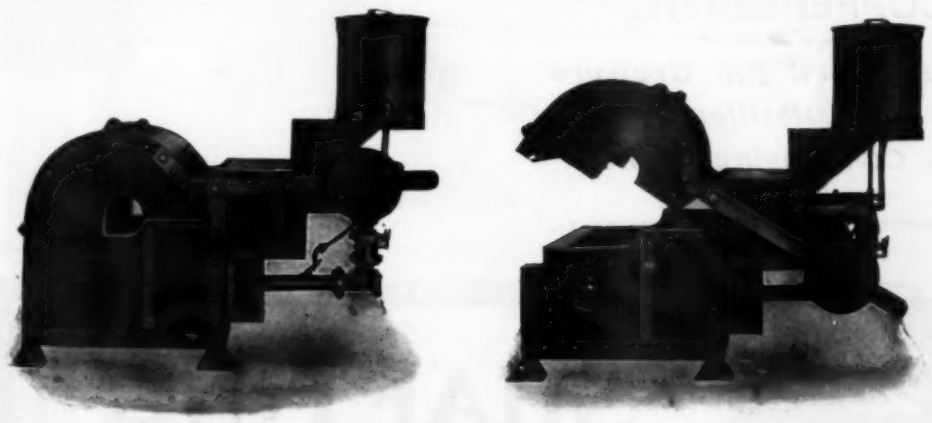

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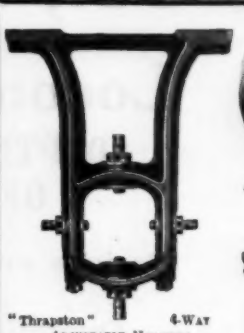
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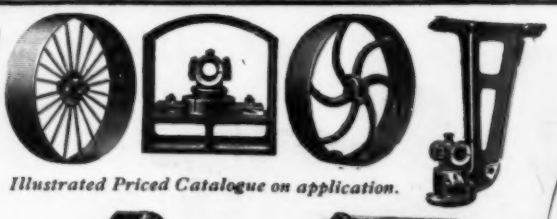
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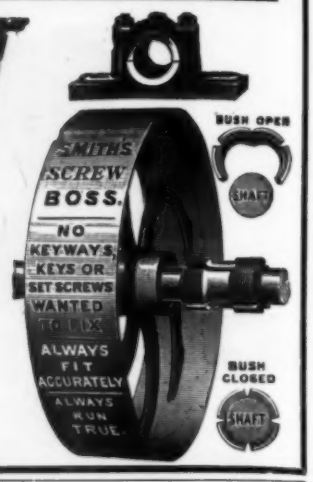

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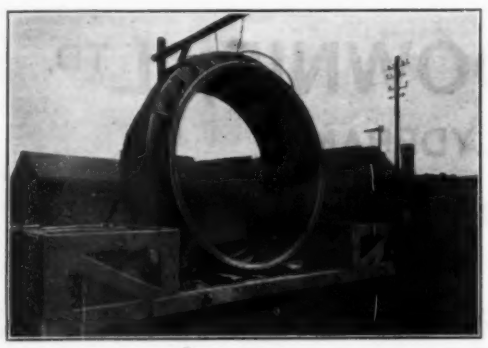

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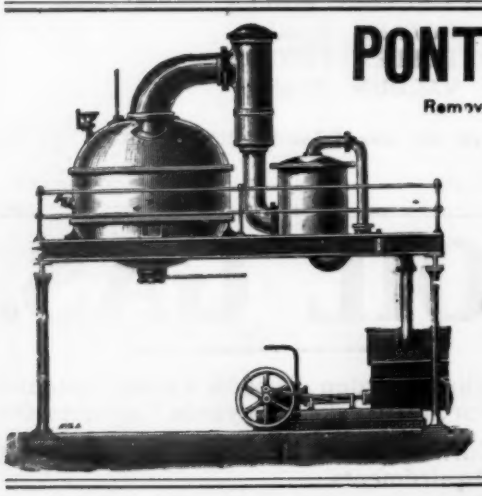

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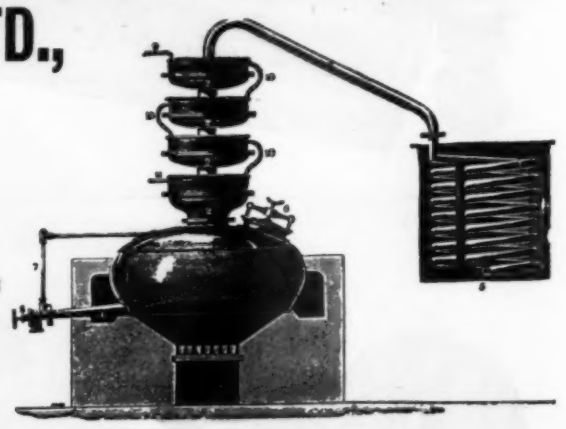

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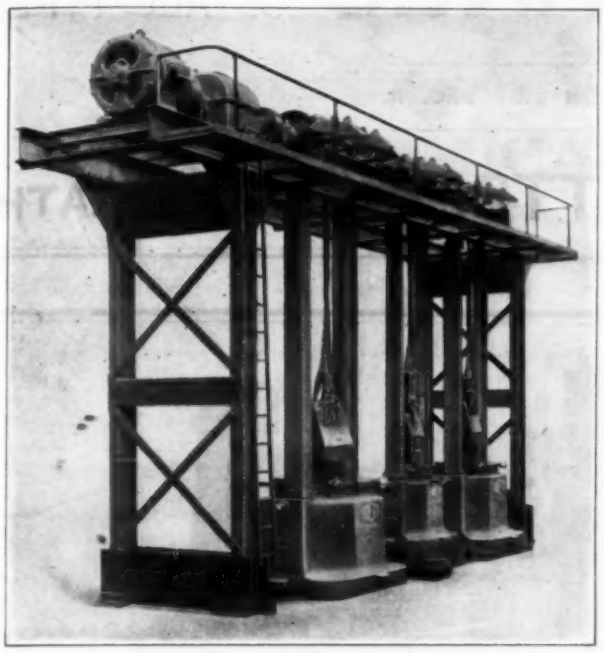

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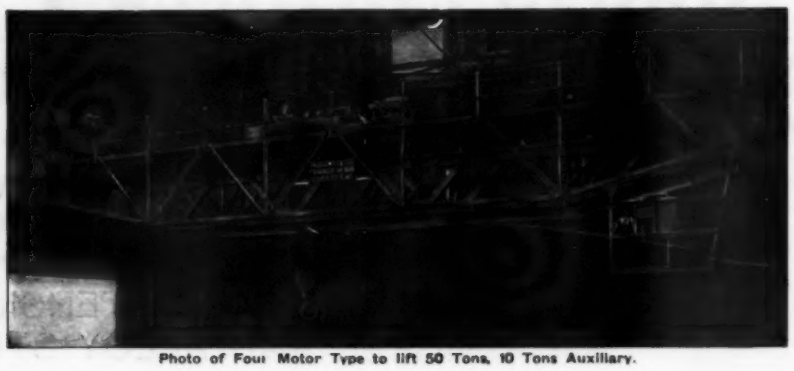
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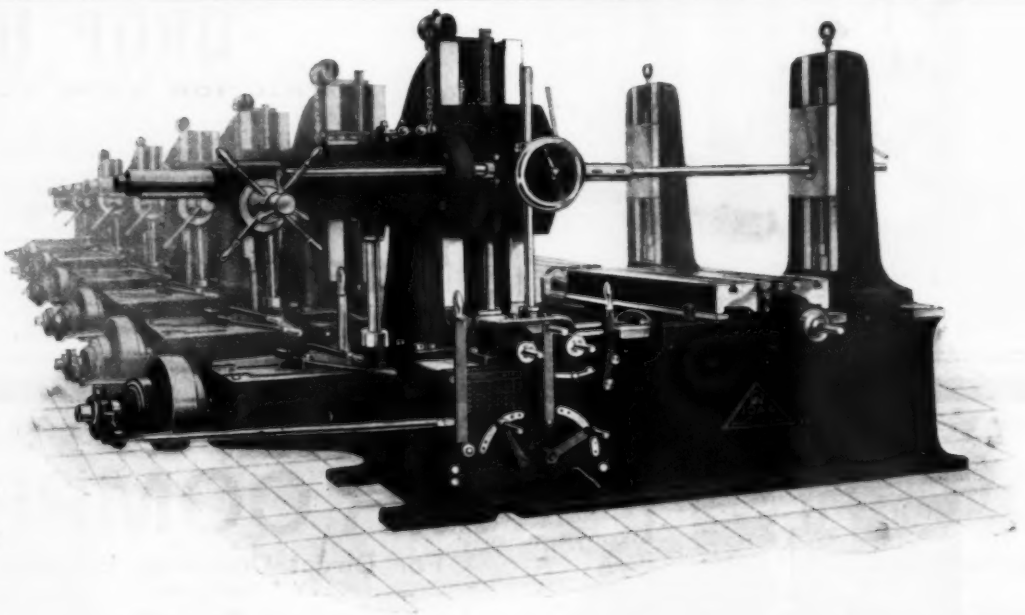

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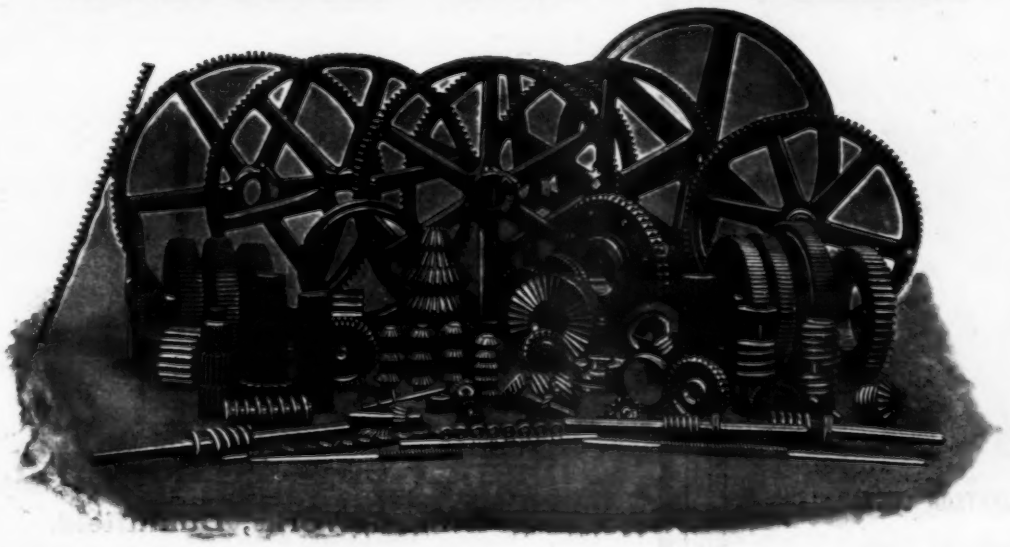

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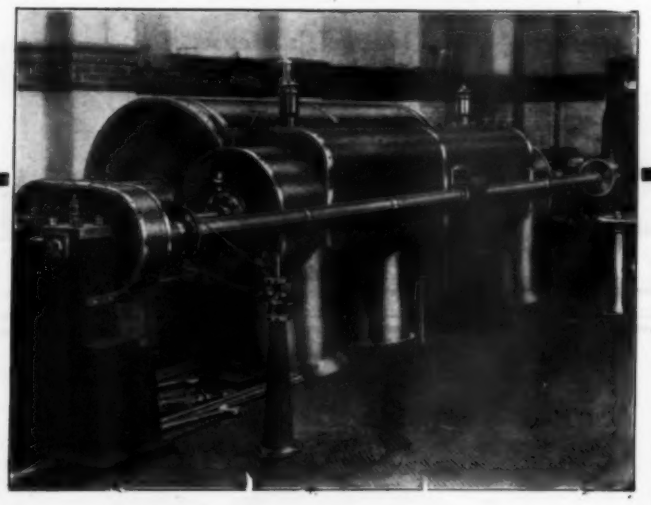

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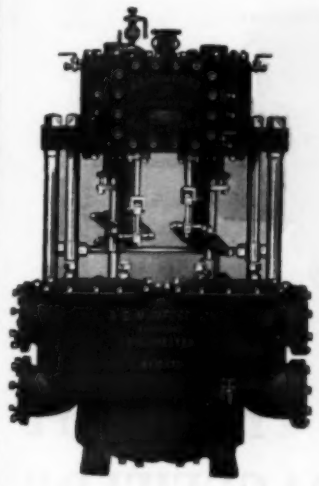

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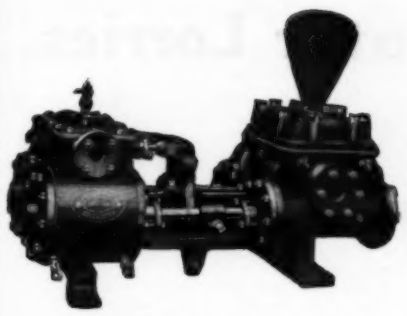

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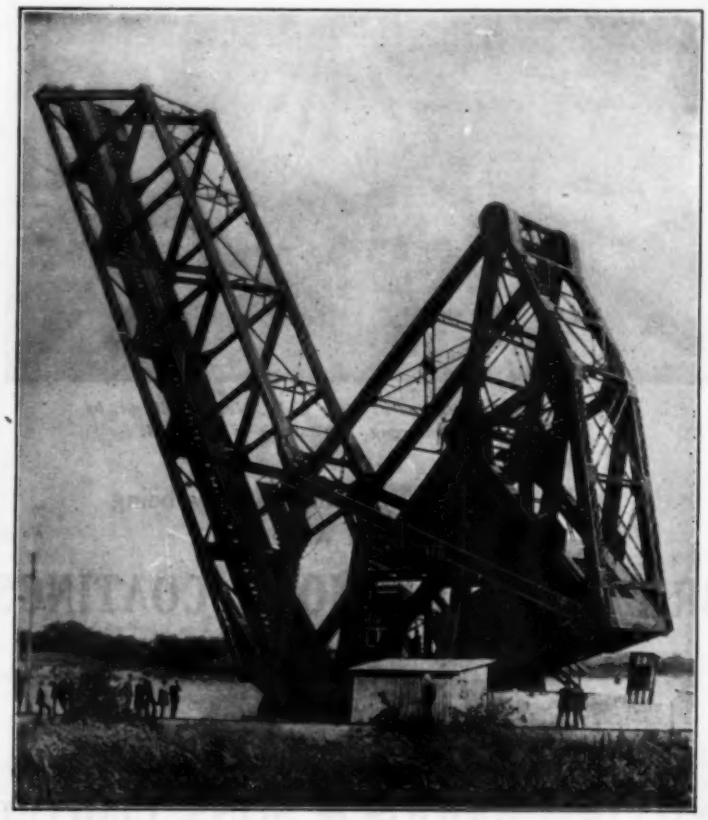

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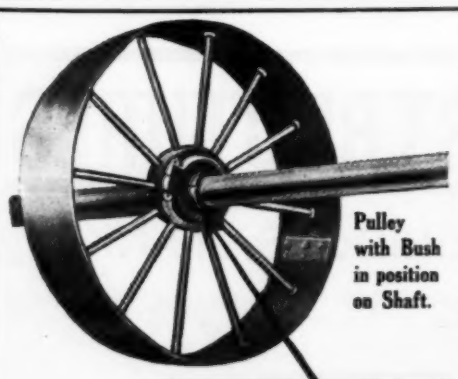

Pulley with Bush in position on Shaft.

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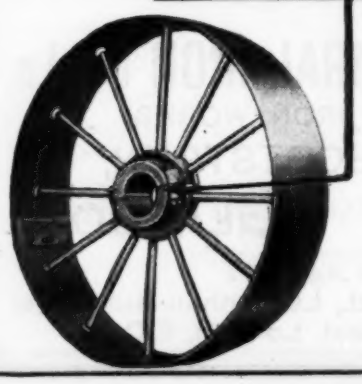

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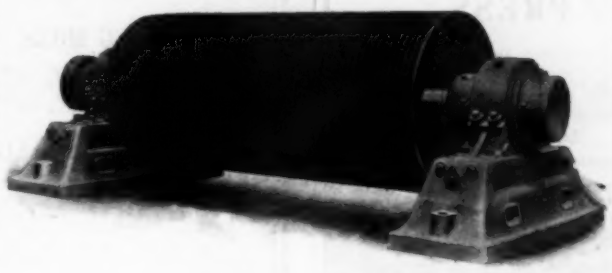

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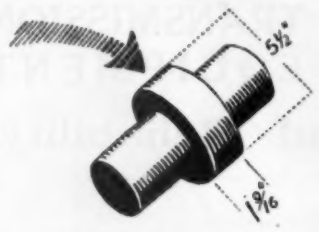

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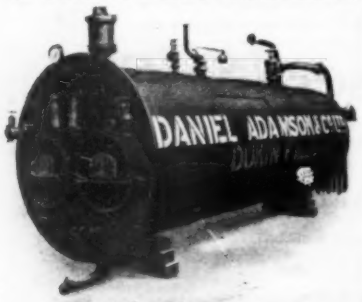

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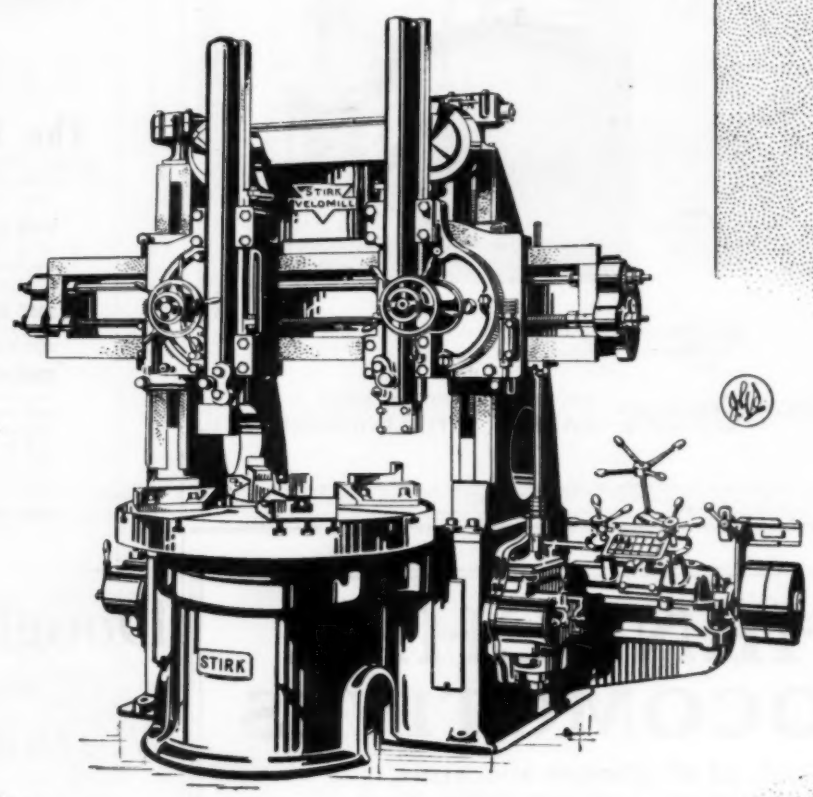

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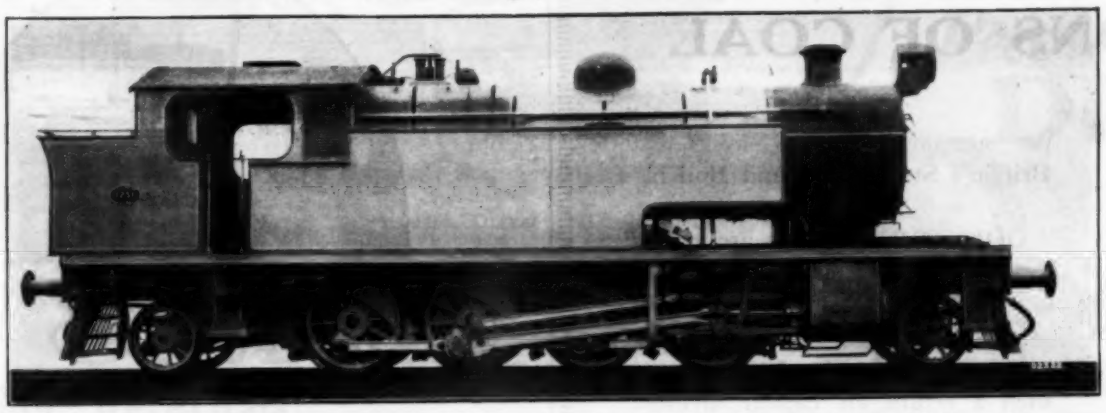

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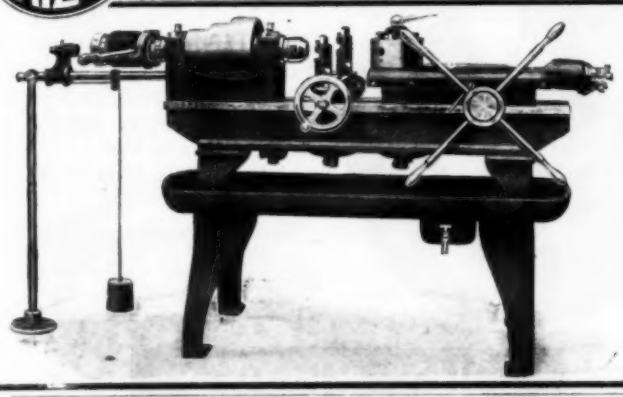

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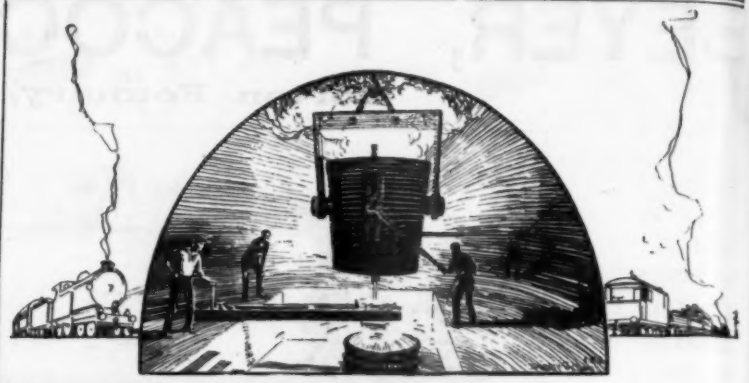

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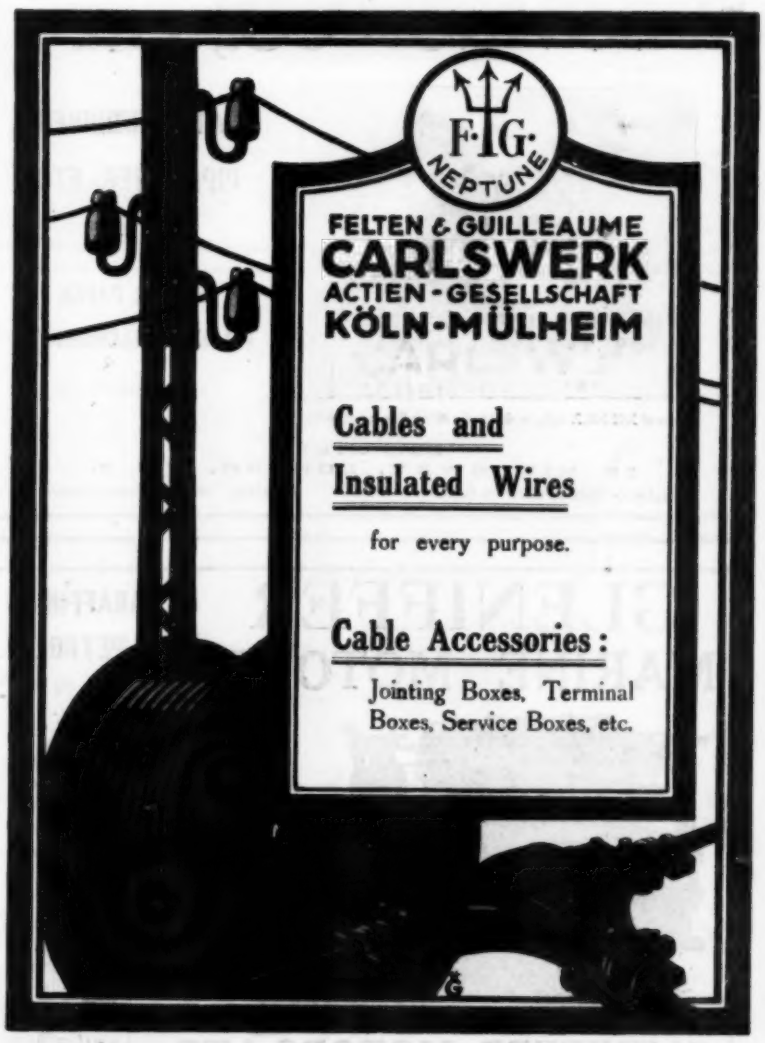

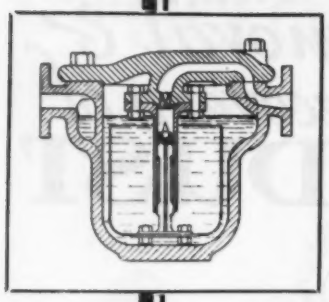

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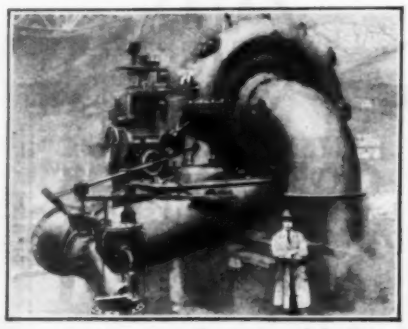

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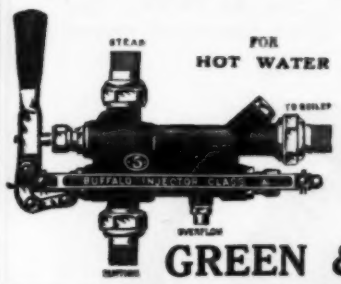

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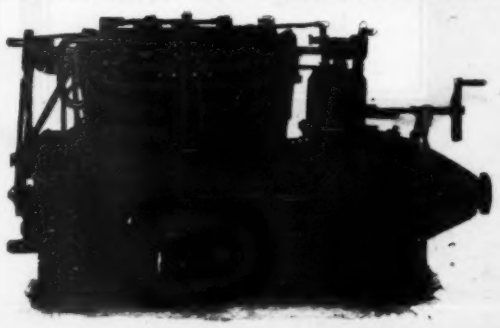

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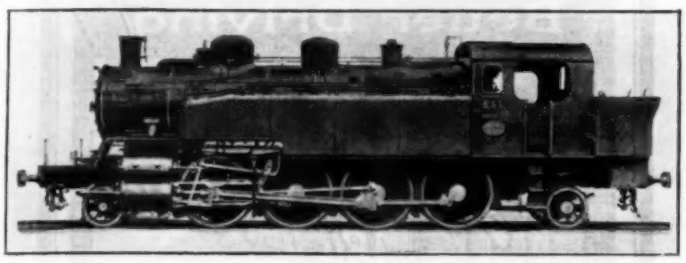

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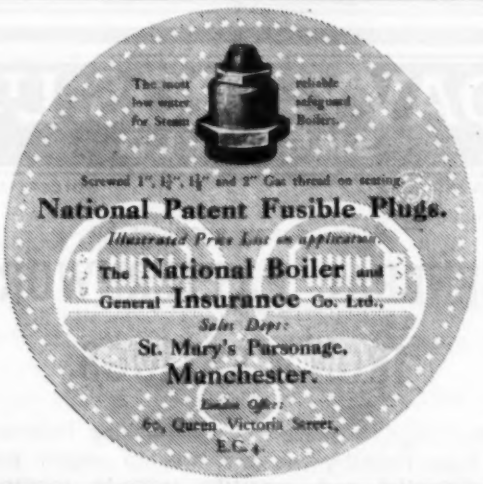
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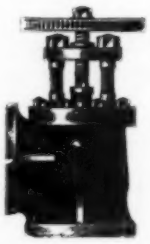

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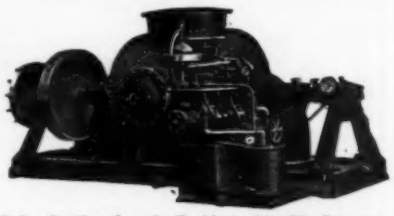

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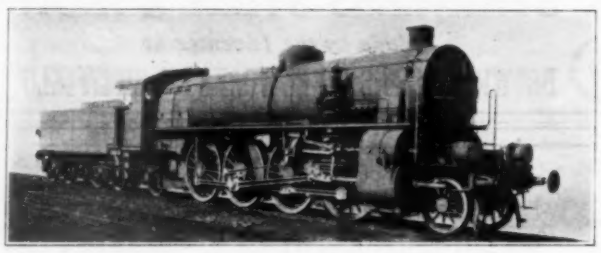

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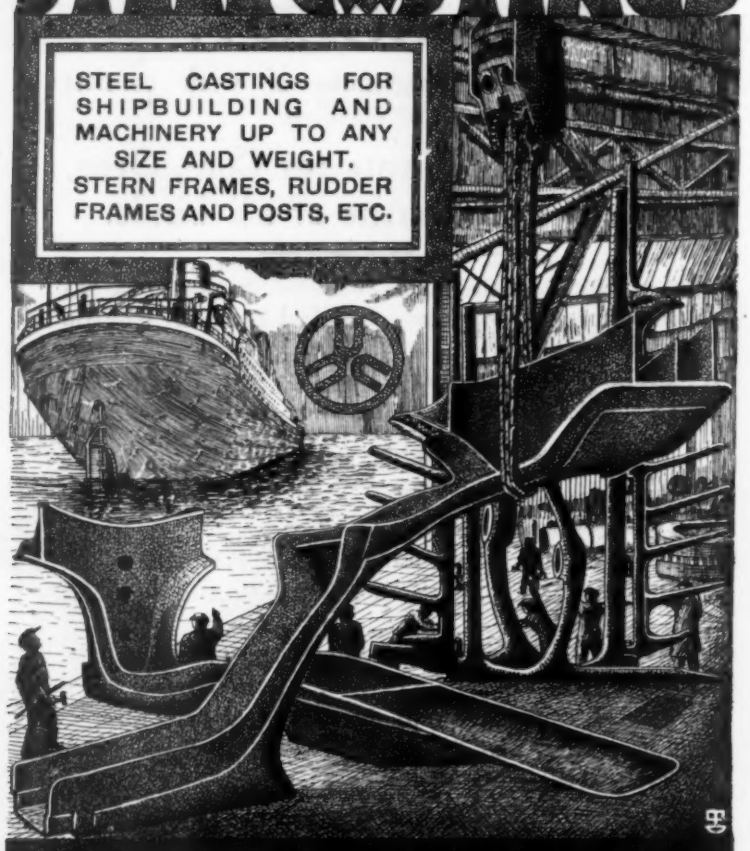

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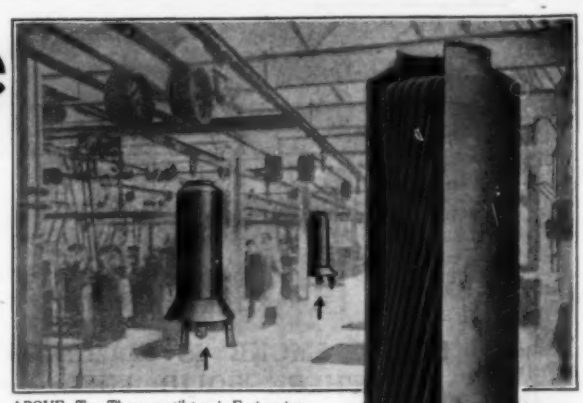

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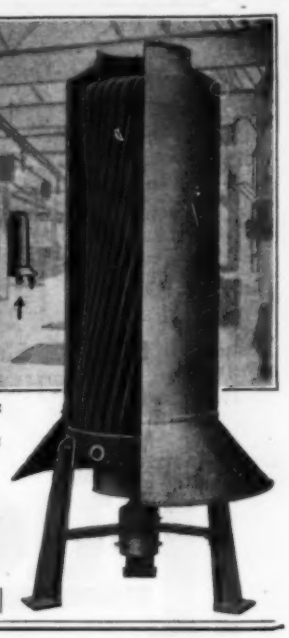
AT SIDE: View of Unit with part casing removed to show interior.



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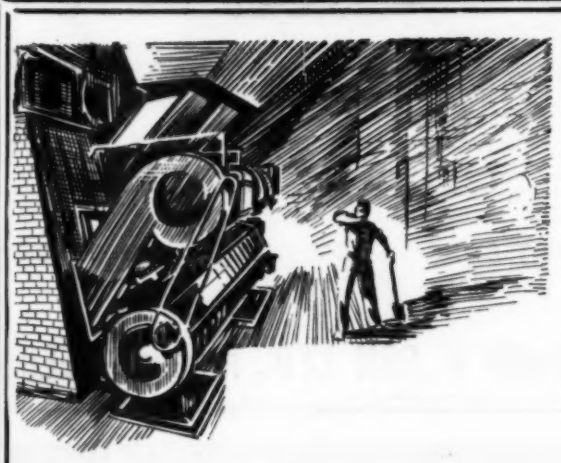

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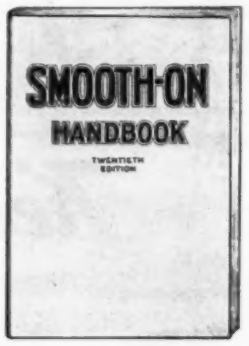

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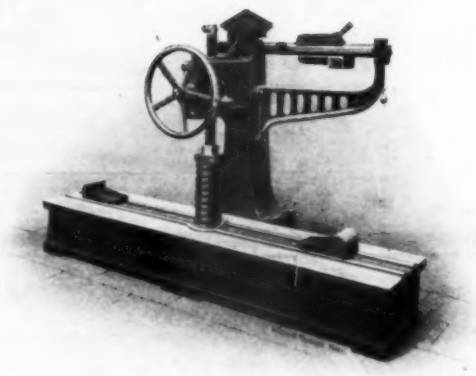

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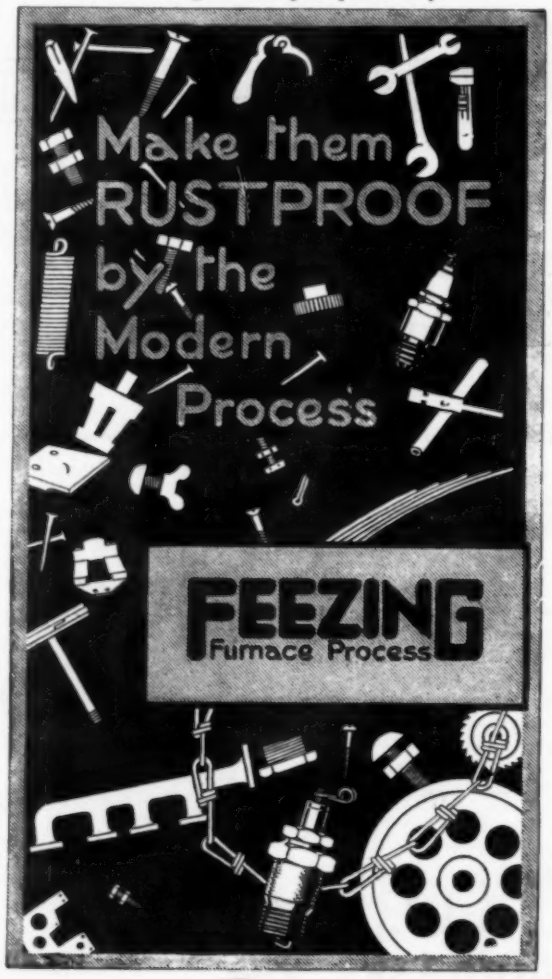

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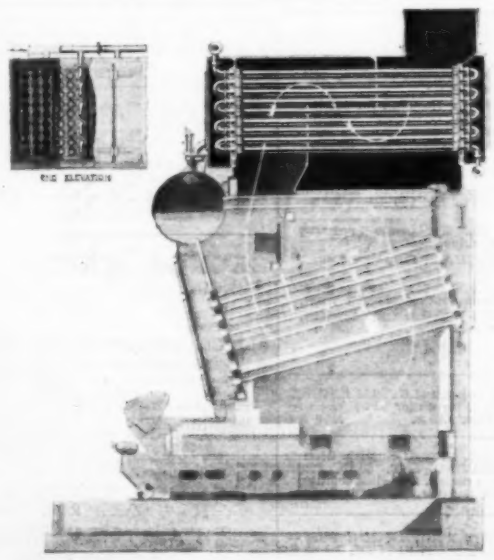

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